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CONTENTS.

EDITORIAL: PAGE
Paragraphs ... 461
ILLUSTRATED ARTICLES:
Fireproof Switchboards ... 463
Electricity in Mining—V ... 465
Electric Drill Plant ... 466
Elements of Practical Electricity, by Dr. Louis Bell ... 466
Measurement of Power Developed by Alternating Currents in Any Circuit, by Carl Hering ... 467
Compensating Shunts for Galvanometers ... 468
Combined Arc and Incandescent Plant ... 468
Polyphasal Generators, by M. I. Pupin ... 468
MISCELLANEOUS:
Latest Foreign Electrical News ... 462
Edison Rumors ... 462
Electrical Progress in 1891 ... 462
History of Electricity, by P. F. Mottelay ... 464
A Change of Publication Office ... 471
FINANCIAL INTELLIGENCE: The Electrical Stock Market, 471; New Incorporations, 441; Affairs of the Companies, 471.
SPECIAL CORRESPONDENCE: New York Notes, 471; Philadelphia Notes, 471; New England Notes, 472; Western Notes, 472; Cana Notes, 472.
NEWS OF THE WEEK: The Electric Light, 473; The Electric Railway, 473; Legal Notes, 473; Personals, 473; Miscellaneous Notes, 473.
INDUSTRIAL AND TRADE NOTES ... 473
BUSINESS NOTICES ... 474
OUR ILLUSTRATED RECORD OF ELECTRICAL PATENTS ... 474

A Victory for the Trolley.

JUST as we go to press the news comes that the Brooklyn Board of Aldermen has authorized the use of the trolley system on the surface lines of that city. Let the work of progress go on until the last horse is retired from service!

The Measurement of Alternating Currents.

ELSEWHERE in our columns may be found the first part of a very practical paper by Mr. Carl Hering on a subject about which there is much popular misapprehension. Alternating current practice has been a great electrical educator, compelling electricians to master the theory of their subject as well as some singular phases of its practice. So long as it was possible to pin one's faith to the simplest form of Ohm's law electrical calculations were anything but difficult, but when the days came that introduced the ideas of self-induction—completely upsetting preconceived notions of resistance derived from continuous currents—lag, and spurious currents possessing no value in watts, the mind of the electrician was driven into open revolt. Even now when alternating current is much better understood than it used to be, there is much popular misapprehension on the subject, and Mr. Hering does an exceedingly useful work in explaining in a simple and practical way the measurement of alternating currents as influenced by their very peculiar properties. This paper is a clear and popular exposition of the facts in the case, and ought to be of great use to those who are beginning the study of alternating currents, and, indeed, may be read with profit by many a man who thinks he already understands the subject. At the present day the electrician whose knowledge is confined to continuous currents is wofully behind the times, even if his practice be confined to the continuous current system. He is unwise if he does not acquaint himself with the work that is being done along a very different line. The success of the Lauffen-Frankfort plant during the past summer has so impressed the importance of the subject on the public mind that such a popular discussion as Mr. Hering's is particularly timely.

Compound Winding Litigation.

AN interesting patent suit—as will be noted in our cable dispatch this week—has now come up for final decision in England. It is nothing less than an attempt to substantiate Mr. C. F. Brush's English patent for the method of winding dynamos granted in 1878. The action has been in progress for several years, and at its last trial a vast amount of testimony from experts—Sir William Thomson among the number—was taken. The defense was on the ground of want of novelty in Brush's invention, and a specification of a patent granted to Mr. S. A. Varley in 1876 was put in evidence; a case was also found in which machines embodying a similar sort of winding had been used in London about 1877. The case was originally brought before the courts in Scotland and the patent was finally ordered revoked on the ground of lack of novelty. Appeal was taken, hence the present trial. As, from the date of the original patent, it is now on the point of expiration in England, the final result does not possess a high degree of commercial interest here, but it is of a great deal of historical interest to determine the first invention of this very ingenious method of compensating the fall of potential due to increasing load. The argument for the present trial lasted some days, and the main question before the court was whether the substance of the Brush patent was disclosed in the Varley patent. It is altogether probable that in 1878 neither specification would have enabled one skilled in the art—as it was at that time—to produce a constant potential machine; according to our modern ideas of compound winding a considerable degree of development was necessary. It is, in fact, one of the cases where an equitable decision is exceedingly difficult, as frequently happens when partially developed improvements are brought out at or near the same time during the progress of a rapidly growing art. It would be highly satisfactory to American pride to have the Brush patent sustained, and a few days will doubtless enable us to know the finding of the court and the final result of the action.

Polyphasal Generators.

THE last meeting of the American Institute of Electrical Engineers was given especial importance by Dr. Pupin's very careful and thoughtful paper on rotary current generators. The following comment by the chairman of the evening—Prof. Elihu Thomson—upon it was thoroughly justified: "This paper contains the only clear exposition of the principles which underlie the polyphasal current system that I have anywhere seen yet." Initiated by Nikola Tesla, and carried to success on a considerable scale by Dobrowolsky and Brown, the drehstrom generator and motor have been the electrical topic of the hour. Dr. Pupin's discussion of the subject—somewhat mathematical for a body less scientific than that before which it was read—is a very clear exposition of the principles that underlie the generation of polyphase currents. But it passes beyond the theoretical and takes up the intensely practical problem of producing an available polyphase generator capable of producing a rotary magnetic field of constant intensity. As is now tolerably well known the rotary field in the Tesla motors, and in their later modifications by Dobrowolsky, is by no means constant. The latter's machines give a field subject to periodic variations of 14 per cent. Such a variation is a slight disadvantage, and to diminish this variation as far as it can be done by increasing the number of phases provided, would introduce unpleasant complications. Dr. Pupin points out that it is theoretically and probably practically possible to secure in the polyphasal generator almost perfect constancy in the resultant rotary field. The method by which this may be done is to produce an electromotive force varying not according to the ordinary sine law but according to some more complex law, so that its variation from the sine curve results, when the phases are combined, in producing a constant field. The exact form of electromotive force curve shown in Dr. Pupin's paper is an impracticable one, but it is possible, probably by proper proportioning of the pole pieces and armature coils, to obtain without great difficulty enough variation from the simple sine curve to compensate, for the most part, the present variation in the intensity of the resultant field. Strange irregularities are sometimes seen in the electromotive force curves of commercial machines, and may be produced deliberately with a little attention to designing. Apart from these details Dr. Pupin's paper is the most useful contribution to the growing literature of a much misunderstood subject, and as such is worthy of careful attention.

Suburban Electric Service.

A RUMOR has recently appeared in the daily press that formal action has been taken by the Illinois Central Railroad authorities looking to the substitution of electric motors for locomotives in the suburban service of their lines. Such action is taken largely on account of the strenuous efforts that are being made in Chicago to lessen the smoke nuisance, which has become well nigh intolerable. The Illinois Central Railroad has a location that is especially favorable to a first class train service, inasmuch as its tracks lie along the lake shore for half a dozen miles without a single street crossing and are walled in so that it is possible to run at almost any desired speed permitted by the necessity of frequent stops. This somewhat advantageous situation would operate in favor of electric traction both as regards speed and as rendering possible a power station within very easy reach of both coal and water supply. Nevertheless, the heavy traffic and frequent stops necessarily limit the speed and make the economy of such a substitution of motive power somewhat doubtful. The conditions are not nearly so favorable as upon elevated roads, where the light locomotives work under a considerable disadvantage and with a far less degree of economy than is found in ordinary railway practice. On the Illinois Central lines the locomotives can be, and are, employed as efficiently, probably, as is possible on any line with frequent stops, hence it is difficult for electric motors to compete with them in view of the low average speed that can be maintained. Truth to tell, it is one of those cases which lies in debatable ground, where it becomes an open question whether steam or electricity will be preferable in point of expense, aside from the initial expenditure involved. We earnestly hope that the experiment will be tried, as it will be a great advantage to the public even if it should prove to be somewhat more costly than the present methods. The point on which the matter hinges is the best efficiency that can be obtained from the motors. If gearing is employed, and if their total efficiency does not rise above 75 or 80 per cent. it is almost certain that the expenses will be greater than they are with locomotives. On the other hand if the motor armatures are centred upon the axles as upon the City and South London Railway and their total efficiency can be brought to 85 or 90 per cent. the electric locomotive is likely to beat steam at its own game; the margin is quite narrow in any event. With the large machines that would be necessary motor efficiency is easy to secure, and the less it is sacrificed by unnecessary gearing the better. It should be quite possible to bring it to the point of efficiency just mentioned, in which case the issue of the experiments would not be doubtful, and would probably be highly satisfactory to the friends of electric traction.

An Interesting Bit of History.

PATENTS extraordinary in character and history are becoming alarmingly frequent, but we must preserve a unique position for one which has just been granted to Mr. George F. Green for an electric railway. The daily papers have within the past few days given somewhat sensational accounts of his inventions. The facts are these: Mr. Green has been for many years a resident of Kalamazoo, Mich., earning a livelihood as a working mechanic, and filling up what small spare time his trade allowed in the study of electricity. Years ago, in fact as early as 1856, shortly after the striking experiments of Page had drawn attention to electric traction, Mr. Green, like others of his countrymen, was impressed with the importance of the subject, and spoke of it to his neighbors. In 1875 he was enabled to put his ideas into practice on a small scale, and constructed a little track on which to run a train of cars drawn by a motor of his own construction, which was supplied by current from storage batteries through the medium of the rails as conductors. Later, in 1879, another and larger model was constructed capable of embodying the same ideas. The inventor fully appreciated the advantages of the dynamo for the purpose of supplying current, but he was poor and no dynamo was available. In fact, in 1879 he was compelled to act as his own patent attorney, and he claims which he then put in were technically informal and hence encountered many obstacles in the Patent Office; interferences were declared and his application—even after an appeal to the Commissioner of Patents—was finally rejected. Not discouraged, however, and firm in the belief of his priority, the inventor carried the case to the Circuit Court of the District of Columbia, the final legal resort after an adverse decision by the Commissioner. It after reviewing the evidence passed favorably upon his application; and, pursuant to the decision of that court two patents were granted on Dec. 15. Abstracts of the claims of both these patents may be found in our patent record this week. They form, indeed, an interesting chapter in the history of electric traction. Although similar ground had been covered in the days when the primary battery was the only available source of electricity, Mr. Green's work was done long before the final impulse had been given to electric traction by the researches of Dr. Werner Siemens and contemporaneous inventors in this country. It forms the connecting link between the old and the new in the history of the application of the motor to railway service, and whatever its value as a patent may be, as a contribution to our history the documents granted a couple of weeks ago possess no small importance. The work of the pioneer is difficult, especially when it is hampered by poverty, and it is hard to give too much credit to those persistent inventors who, in the face of all sorts of obstacles, have carried through their first crude ideas to working success. With more money, or more influential friends, it might have been Mr. Green's fortune to carry out such an experiment as a few years later in Berlin drew the attention of the world to the possibilities of the electrical distribution of power in facilitating rapid transit.

Latest Foreign Electrical News.

(By Cable from Our Own Correspondent.)

London, Dec. 21, 1891.—In the trial going on in the House of Lords and involving the Brush compound winding patents granted in 1878 a decision is expected daily. The suit has now been in progress for several years and has been appealed from court to court until the present.

Electric lighting has apparently taken a firm hold on the Bradford municipality, for it has just been decided to extend considerably the present lighting area. In fact, electrical affairs generally seem to be in good condition, and the Electric Construction Corporation has just been fortunate enough to declare a dividend of six per cent.

An interesting demonstration is in progress at Birmingham to-day, being a practical test of the improved Bernardos electric welding process. It will be remembered that the Bernardos process was essentially that of heating the surfaces to be worked by passing an electric arc between them, although since its announcement several years ago it has been extensively modified.

A new electrical journal will be in the field at the beginning of the new year. Its title is *L'Industrie Electrique*, and M. Hospitalier is to be its editor, which speaks well for its probable chances of success. M. Hospitalier's experience both as electrician and editor is very wide.

At the meeting of the Physical Society last week, Prof. W. E. Ayrton showed some very beautiful experiments with rotary currents, causing fine platinum wires to glow successively, showing that they were traversed by two currents in quadrature with each other.

On Friday last an important injunction was granted by Judge Kekewich at the instance of a shopkeeper on Bond street. The injunction was to restrain the use of the Grosvenor Gallery sub-station of the great Ferranti system. The judge held that the state of the art was not sufficient at present to admit of placing reliance on the statements of the defendants with regard to the safety of future operations. It will be remembered that this station was the one disabled by fire about a year ago, and that there have been continual difficulties in its operation. The judge held that in its present locality in the heart of a crowded city conditions of safety were not properly fulfilled. What will be the upshot of this injunction remains to be seen.

Edison Rumors.

Considerable discussion has been provoked during the past week by the rumors circulated around Wall street to the effect that Henry Villard, president of the Edison General Electric Co., had been asked to resign. No confirmation of these rumors could be obtained, Mr. Villard and the others interested declining to either affirm or deny them. Commenting on the above, a well-known gentleman said:

"The absence of any representative of Drexel, Morgan & Co., the heaviest Edison stockholders, at the recent Edison dinner given by Second Vice-President Insull at Delmonico's is very significant. The talk as to these bankers' dissatisfaction with the present management of the Edison company certainly received emphasis on this occasion."

The Electrical Progress of 1891.

The past year has been one of great interest to the practical electrician, and although notable advances have been made in nearly every line, the most remarkable have been in that new and ever-growing field of electrical work—the electrical transmission of power. In every department this latest development of electrical science has, amid the steady march of all things electrical, advanced with gigantic strides. It has been the agreeable duty of The Electrical World to record progress in every department, and especially in this.

The oldest department of applied electricity—the telegraph—is probably the one in which least improvement has been made during the year, and yet it has been the prolific subject of discussion. All through the year 1891 the subject of government control of telegraphs has been constantly agitated, with no special result as yet, but with a persistence that has been simply untiring. It has best found its expression, perhaps, in the paper read by Mr. E. Rosewater before the New York Electric Club (XVIII., 436), and the subsequent discussion (XVIII., 455). It is a topic that is a favorite one with political economists of a certain sort, and has been industriously forced on public attention.

The telephone has been more fortunate, in fact the present year has been notable in telephonic circles, not so much on account of general improvement in practice as through the sensational patents that have been granted. On the theoretical side of telephony two very important papers, however, have been read, both dealing with the same subject—the cause of and remedy for inductive disturbances in telephone circuits. Both of these were read before the American Institute of Electrical Engineers, one by Mr. J. J. Carty, (XVII., 241), which, followed by its discussion (XVII., 276), forms a most interesting contribution to the literature of the subject, showing as it does the powerful electrostatic effects that are encountered, and their effect on telephonic service. Immediately following this (XVII., 277) was Mr. A. E. Kennelly's theoretical discussion of the phenomena. But it was reserved for the latter part of the year to stir up such a sensation in electrical circles as has seldom been witnessed. It had been rumored for some time that the American Bell Telephone Company was seeking a new lease of corporate life after the running out of its fundamental patents through the issue of patents on applications dating back to the early days of the art and not granted—through an unfortunate combination of circumstances—until the present time. It was not until October, however, that anything definite was done, and in November a broad patent on the microphone transmitter was issued to Emile Berliner; one of the first inventors in the field; although bearing date of 1891 it was on an application dated more than 14 years previously. The history of the invention was described in The Electrical World (XVIII., 397) by the inventor himself, and is a most interesting contribution to our knowledge of the early state of the art. The patent in its relation to telephonic work was so important that considerable space was devoted to an elaborate discussion of the history of the subject (XVIII., 396). An interesting sequel to the issuance of this extraordinary patent was that issued to Mr. Charles Cuttriss and illustrated in The Electrical World (XVIII. 474). This interesting invention attains by means quite different from those used in the ordinary transmitter the same excellent results.

The completion of the telephone line between London and Paris is another interesting event of the year, and has been fully described by Mr. W. H. Preece, head of the English Postal Telegraph system (XVIII., 256). The long distance service has been growing steadily throughout the year, and one new and particularly fine exchange has been erected in Boston (XVIII., 75).

The electric light has gone on through a period of steady growth; a large number of important plants have been erected and put into operation, some of them being of special interest; they have been fully described in our columns from time to time.

The two electric light conventions brought out matter of great interest. The convention at Providence was made notable by a number of valuable papers, among them that of Prof. Elihu Thomson on arc lighting (XVII., 166); Mr. T. Carpenter Smith's very important paper on the distribution and care of alternating currents (XVII., 172), and Mr. Markland's paper on the peculiar conditions of electric lighting to be met in illuminating railway stations and yards (XVII., 158). During that convention, too, a day was set apart as Pioneers' Day, devoted to hearing from those who had taken an important part in the development of electric lighting, the story of the beginning of the art. The report of this conference is of great historical interest (XVII., 161).

The following convention at Montreal was even more important and several of the papers are worthy of special mention, particularly those by Mr. J. I. Ayer on the care and management of an arc lighting station, derived from his experience in managing the largest arc light station in the world (XVIII., 317); Mr. Redman's paper on operating central stations by water power (XVIII., 204); and, more especially, the formation—with the authority of the National Electric Light Association—of a very valuable series of rules for the safe wiring of electrical circuits (XVIII., 214). A little later in the year came a most interesting paper read by Prof. Wm. D. Marks before the Association of Edison Illuminating Companies, dealing with a very important portion of electric lighting—the problem of getting a paying load for a central station (XVIII., 382).

During the early summer the all-absorbing topic of interest was the issue of one of the most important suits that has been brought in the history of patent law, that between the Edison and Westinghouse interests, involving the validity of the incandescent lamp patents. It had been hanging fire for some years, but finally came before the Circuit Court. The arguments occupied an entire week, and were quite fully reported in the columns of The Electrical World, and at the same time a résumé of the features of the litigation was brought before the public (XVII., 412, 434, 443, 464). Some time elapsed before Judge Wallace's final decision, and when it came The Electrical World was the first journal of any kind to place the full text of the opinion before the public (XVIII., 55). The decision was emphatically in favor of sustaining Edison's patents. The case, however, was appealed, and early next year will be brought before the Circuit Court of Appeals for final adjudication. Apropos of this decision came a careful paper by Dr. L. K. Böhm dealing with the inner history of the incandescent lamp in this and other countries (XVIII., 175).

The electric transmission of power has occupied, as before mentioned, a very important place in public attention. We may conveniently divide it into two quite distinct portions—the electric railway proper, and the transmission of power for other purposes. Of general papers on the subject, perhaps the most striking during the current year was Mr. O. T. Crosby's discussion before the American Institute of Electrical Engineers on high speed electric traction, being the result of extensive experiments tried some time previously. It is the most exhaustive treatment of the topic that has yet appeared (XVII., 207). Dealing with the same subject in a somewhat different way is Prof. Marks' paper before the Franklin Institute (XVII., 18).

During the early part of the year the subject of rapid transit for New York excited a great deal of attention, and the application of electricity to this task was much discussed, most elaborately perhaps by Mr. F. J. Sprague (XVII., 143, 457). This same topic of high speed electric railroading on a large scale has also taken a prominent place abroad, and a plan has been proposed for such a system between Budapest and Vienna, originally suggested in the early part of the year and elaborately discussed by Carl Zipernowsky in the paper before the International Congress at the Frankfort Exhibition (XVIII., 269). Of more ordinary electric railway work the amount has been almost endless, and many have been the contributions to our practical and theoretical knowledge of the subject. The most important single paper perhaps was that by Mr. J. S. Badger, giving the results of very extensive research into the running expenses of electric roads and the conditions of economy (XVIII., 335). Aside from that, several valuable tests have been conducted on street car lines bearing on various practical phases of the subject. One of them is an exhaustive study of the typical power station (XVII., 418). Another and more important in its way is Mr. Hewitt's exceedingly interesting application of a continuous speed recorder to studying the conditions of electric street car service in cities, a paper doubly valuable because it involved a pretty thorough test of some of the new forms of street railway motor (XVIII., 447). And this brings us to a very radical change that has come over street railway practice within the current year—the substitution of the old railway motors with double reduction gears by new machines of much lower armature speed, some of them designed for a single gear reduction and others to be placed directly on the axle of the car. The latter construction may perhaps have derived encouragement from the successful career of the City & South London Railway (XVIII., 301). The first of these new motors to appear was the Baxter, a single reduction gear motor (XVII., 3). But it was rapidly followed by a group from the Westinghouse and Thomson-Houston, Short and Edison companies (XVII., 93, 191, 155; XVIII., 274, 322). The introduction of these new machines has had a very strong influence on the art of electrical traction, for they are mechanically much superior to their predecessors in point of freedom from noise and lack of repairs needed, and mark a most decided advance. They have already displaced many of their older competitors and few double reduction motors are likely to be made and used. Almost immediately after the appearance of the first of these machines came the Short gearless railway motor (XVII., 256); followed very soon by the Westinghouse gearless, (XVII., 275). These two machines are both of great interest and are radically different in construction, the former supporting the entire motor flexibly, centring the armature on a sleeve concentric with the axle but not touching it, and driving it through the medium of a spring connected spider. The latter machine is notable for its designer having supported the entire motor on the axle and connected the armature firmly to it, a simpler construction, perhaps needlessly feared by other designers on account of a supposed danger from mechanical shocks. Still another construction of gearless motor was devised by that veteran electrician, Eickemeyer, and has all through the current year been undergoing gradual development; in fact, it was tried last year. A number of cars are now in operation and the final form of the machine possesses many points of interest (XVIII., 381). The single reduction gear motors have now been on the market long enough to permit some judgment to be made as to their merit; they are unquestionably as a whole good. The gearless motors are certainly promising, but not enough of them are now in regular use to show whether they are more desirable than the single reduction gear machines or not.

The Street Railway Convention at Pittsburgh was a most important gathering, attracting especially valuable exhibits of every kind. Without pausing to review the proceedings in general a full report of what was said and done will be found in our columns (XVIII., 323).

Of general railway apparatus there has been a flood. Of methods, aside from details, only one has excited any interest within the year, and that was the announcement during the autumn of a system of track supply at very low pressures devised by Mr. Edison. The details have been kept dark up to the present, but the principle is looked at askance by prominent electricians (XVIII., 321, 342).

In the transmission of power the event of the year has been a foreign one—the inauguration of the great long distance plant, covering 115 miles, between Lauffen and Frankfort-on-the-Main. It was suggested early in the year (XVII., 137, 291), and its success was then predicted in the most unqualified manner in these columns. The event justified that prediction, for when in the latter part of August the motor was put in position and the first experiments were tried, success beyond question was attained. It was the feature of the Frankfort Exposition. The Electrical World sent Mr. Carl Hering abroad as a special correspondent to report on that important exposition of electrical apparatus, and his notes on the Lauffen-Frankfort transmission are scattered through the summer numbers of The Electrical World (XVIII., 126, 156, 194,

249, 332). The theory involved in these experiments has been the subject of much study at home and abroad, and various paper on the topic have been published. Most notable among them are those by von Dobrowolsky, who developed the apparatus (XVIII., 268); A. du Bois-Reymond (XVII., 477); Ludwig Gutmann (XVIII., 293), and Dr. M. Pupin (XVIII., 468.)

Other interesting examples of the transmission of power have been found in this country, the most notable perhaps being that at Telluride, Colo., in which the Westinghouse alternating system of synchronous motors was employed (XVII., 223). Still other similar plants are proposed, one of them, at least, for the transmission of power at very high voltages.

That particular department which relates to the use of electricity in mining has awakened continual attention during the year; beginning with an interesting paper by Mr. H. Ward Leonard dealing with the general phases of the subject (XVII., 361), and ending with a general review of the entire topic in our columns (XVIII., 402, 414, 433).

Of papers of general and theoretical interest the year has produced many. Two very useful practical discussions were published in our columns early in the year, "The General Theory and Practice of Electrical Units," by A. L. Kimball (XVII., 38, 56, 72), and a similar treatment of alternating current electric motors, by Dr. Louis Duncan (XVII., 341, 357). Among the papers of a partially electrical character is one which is of great importance in its bearing on our theories of the constitution of metals, that by Mr. Reginald A. Fessenden on the relations between atomic volume and tensile strength (XVIII., 123).

The most sensational work of the year perhaps was that done in the new field of research opened by Mr. Nikola Tesla, whose experiments with alternating currents of enormously high frequencies have excited the greatest interest all over the world. They were first mentioned in a paper by him in THE ELECTRICAL WORLD (XVII., 128), and later his experiments were put before the public in a most brilliant lecture before the American Institute of Electrical Engineers (XVIII., 19). A very beautiful application of alternating current theory to the improvement of practice was furnished by William Stanley, Jr., and his coworker, Mr. J. F. Kelly, in the invention of a very effective form of alternating current motor based on condenser action, which will soon be put into practical use on a considerable scale (XVII., 433).

The transformer—that invariable adjunct of alternating current work—has been the subject of elaborate study during the year, and several important papers have been published, notable among them being that by Evershed in England, dealing with the much mooted question of open versus closed magnetic circuit transformers (XVII., 225, 243, 258, 289, 308, 325, 344, 376, 423). To all this we may add the announcement of the very beautiful method of studying alternating currents devised by Dr. Duncan (XVII., 362). And so the story goes.

Coming back to practice again it may be interesting to note what has been done in the storage battery line during the year. First of all, the storage battery suits seem to have been brought to a close by the decision of Judge Coxe in the case of Mr. Brush against the Accumulator Company; this, following a similar decision of the previous year, has resulted in putting the lead battery pretty thoroughly under the control of Mr. Brush and his licensee, but as yet no very important practical results have come from this relief of the accumulator from persistent litigation (XVIII., 83). The progress that has been made during the year to bring forward the alkaline accumulator again, due to the energies of Messrs. Waddell, Entz and Phillips (XVII., 354), is an effort that may be classified as somewhat promising, although the work as yet has not been on a very large scale. Mr. Carl Hering has given a pretty thorough description of the accumulators at the Frankfort Exposition (XVIII., 257, 285). And, finally, the whole subject has been gone over in a very satisfactory and connected way by Mr. G. H. Robertson (XVIII., 8).

Of apparatus that has been brought out and introduced during the year there has been an almost endless variety, both in central station work and in every branch of electrical service. It is simply hopeless to attempt to classify or describe what has been done, so infinitely varied is it in character. No apparatus of a sensational character, however, has appeared, aside from the Tesla high frequency alternator, the "drehstrom" motor, and the Stanley and Kelly condenser motor, all of which have been previously mentioned.

As may be seen from this brief and necessarily imperfect review of some of the important advances of the year in electrical theory and practice, 1891 has been a marked year, and in closing we can only reiterate the statement made in the beginning that 1891 has been emphatically the innings of the electrical transmission of power.

Fireproof Switchboards.

BY M. C. SULLIVAN.

The strides that electricity has made have been so rapid and its growth so enormous in the last ten years that mechanical and artistic perfection of apparatus, such as switchboards, has been subordinated to the necessity of rapid and often faulty construction. Then, too, the stability of the business was for a long time in doubt, and many stations and plants were equipped without considering that they had to stand the test of time.

Now, however, when men and companies have settled down to an even pace, more attention is being given to these two very important elements of electrical construction, as is evidenced by the three magnificent fireproof switchboards shown elsewhere in this article. These special cases are not illustrated because they alone represent what has been done up to the present time. While they stand out in bold relief to the somewhat incongruous creations of a few years ago, it must be stated to the credit of the business that there are many such samples of excellent workmanship, and the tendency all along the line is in the direction of improvement.

The fireproof element of electrical installation has been one of the fundamental principles upon which success has been achieved. Every addition to the list of appliances that have helped accomplish this result has justly been hailed with delight, and the use of marble and slate, which form the main structure of the three switchboards shown herewith, marks a new era in the electrical equipment.

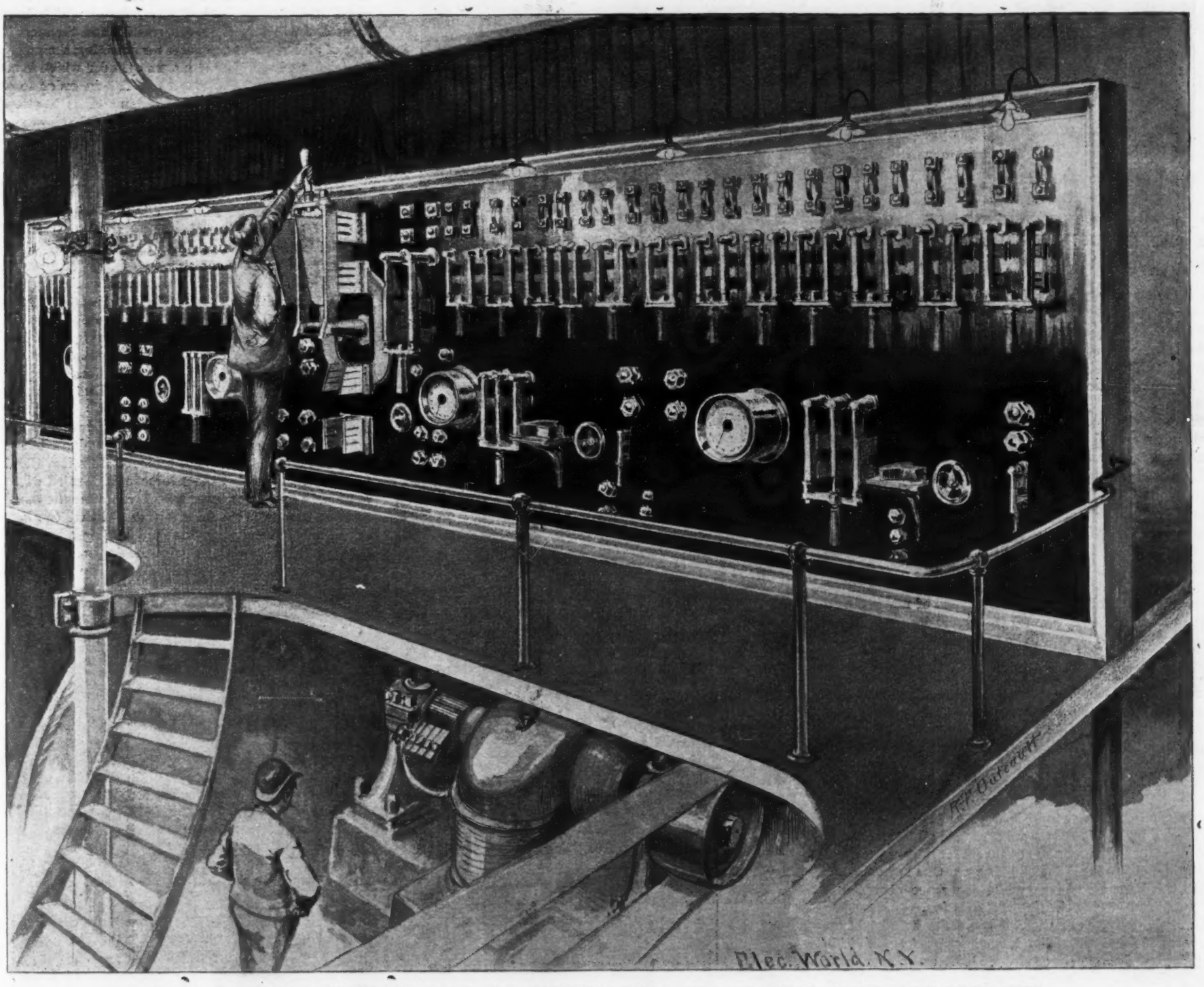

FIG. 1.—FIREPROOF SWITCHBOARD OF THE CARNEGIE MUSIC HALL LIGHTING PLANT, NEW YORK CITY.

The necessity for rapid manipulation in central station practice, as well as in many large isolated plants, is well known. If the indicating instruments, switching devices, resistances and accessories essential to the operation of a plant are placed within easy reach of the operator, as for instance, in Fig. 3, the manipulation of the apparatus is greatly facilitated.

In Fig. 1 is shown a switchboard of the new Carnegie Hall, one of the most interesting ever constructed. It is built above the dynamos, as will be seen. It is 30 feet long and made of marbleized slate. All connections are made from behind, thus keeping out of sight the conductors and resistances which in so many cases have been thrown in a homogeneous mass about the dynamo room. The giant switch in the centre of the board is of the double pole pattern, and is designed to change the polarity of the entire

system each day, under the assumption that changing the current will increase the life of the lamp.

At first sight it would appear that arranging the apparatus in this improved manner would involve an increase in the cost of construction. This is not entirely true. Every piece of metal and every connection here shown are necessary to the running of the installation, the same as if they were put up in the haphazard way which has characterized so many plants in the past. Arranging them artistically and conveniently adds but slightly to the expense.

Before designing a board of this kind it is necessary that all the conditions of the system be understood so that it can be adapted to the space afforded and the work to be accomplished. Such was the case in the present instance. Complete drawings and specifications were sent to the factory of the Thomson-Houston company, at Lynn, Mass., before it was started to be built, and it arrived at the plant complete and ready to be placed in position. This is quite a departure from the old practice of "rigging up" a board after all other work had been done.

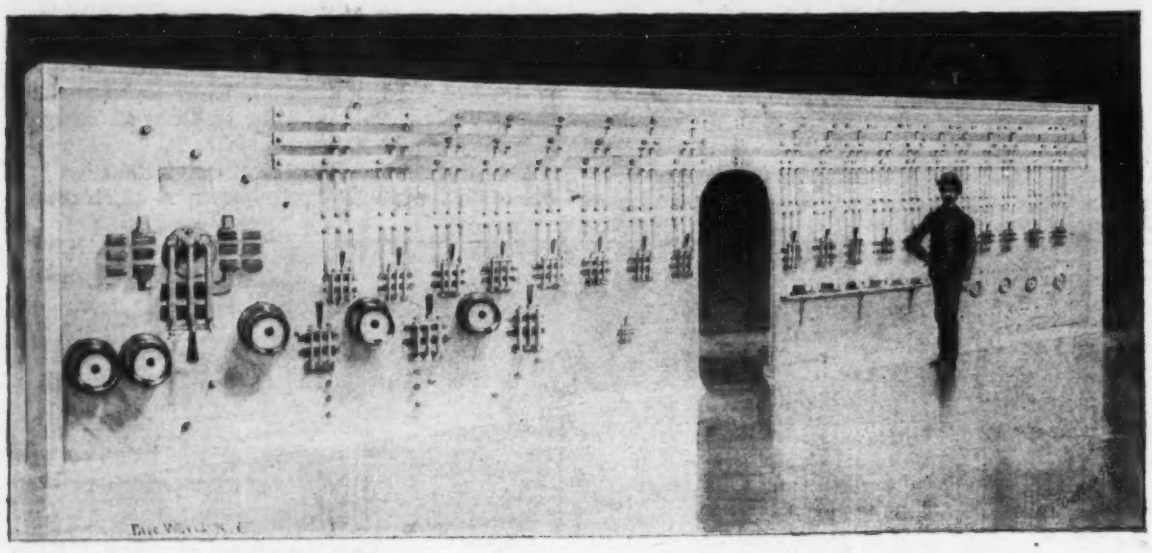

FIG. 2.—FIREPROOF SWITCHBOARD OF THE LIGHTING PLANT IN THE PENN MUTUAL LIFE INSURANCE BUILDING, PHILADELPHIA.

This board, as well as that above in Fig. 2, was designed by C. H. Davis, the well known electrical engineer of 120 Broadway.

In some switchboards of this character, all the instruments are mounted on separate pieces of insulating material, and these again attached to the main board. This practice is not nor should it be favored. It means a more costly equipment without any increased advantages.

Another good example of the progress being made in electrical construction is that shown in Fig. 2, a switchboard in the Penn Mutual Life Building, Philadelphia. It is built entirely of marble, and is very compact and complete. As will be seen, all connections and bus bars are mounted on the front. While this method of making connections is sanctioned by several years' practice, it is an open question whether it is more to be preferred than that shown in Fig. 1. Considered electrically, it is beyond doubt that concealing the conductors is better than to leave them where they are liable to become affected and liable to cause injury to persons standing near, as in the case of high tensions. From an artistic standpoint the concealed wires are the best, because to keep them in good shape necessitates frequent polishing and careful attention.

The cramped quarters of the Twenty-sixth street station of the Edison Illuminating Company of New York necessitated the construction of a switchboard of peculiar design, as will be seen by Fig. 3. Here are arranged all the switches, instruments, resistances and equalizers for the capacity of the station, 50,000 incandescent lamps. One boy can thus control this immense system, while the space occupied is very small considering the size of the station.

The reader may have noticed that all the boards shown are arranged for low tension incandescent circuits. This being but one department of electric light and power work attention is naturally drawn to arc light stations. Here, more than in any other place, owing to the intensity of the current and the absolute necessity for rapid manipulation, as well as safety to the operator, the most perfect apparatus is required. Arc light station managers have recognized this, as a good many of them are arranging to install switchboards to take the place of their now primitive equipments.

Street railway work, from its inception, seems to have had a rare appreciation of these points, as nearly all of them are equipped with switchboards that are not only fireproof, but substantial and artistic.

Slate, both plain and marbleized, seems to be greatly preferred for this kind of work. The former, when finished, is an imitation of marble. This material, however, is uncertain, owing to the presence of metal which destroys its otherwise good insulating qualities. Marble has been quite extensively used. While costing slightly more than slate, its insulation is very uniform throughout.

Electrical work has now passed the experimental and doubtful stage. It is one of the most important factors in our civilization, and, like architecture, as much attention must be given to the artistic points of central stations and isolated plants as to the useful in order to bring electrical installations to the standard perfection.

With a thorough appreciation of these facts in mind, the electrical engineer, if he will but direct his attention in this direction, can accomplish results that will be both satisfactory to himself and beneficial to the industry which he is laboring to perfect.

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Chronological History of Electricity, Galvanism, Magnetism and the Telegraph, from B. C. 2637 to A. D. 1888.—Part I.*

BY P. F. MOTTELAY.

A. D. 1787.——Charles (Jacques Alexandre César), able French physicist and experimentalist, who became the Secretary of the Académie des Sciences, relates many of his electrical experiments in the 30th volume of the *Journal de Physique*.

He was one of the first to study and develop the theories of Franklin, who, in company with Volta, frequently attended the brilliant lectures which Charles was enabled to give in what was then considered the most complete philosophical laboratory in all Europe. In many of his experiments on atmospherical electricity, Charles has been known to produce thousands of sparks, beams or flashes, which exceeded 12 feet in length and which made reports similar to those of firearms. The French Academy indorsed the opinion given the Minister of War by Charles to the effect that a lightning-rod affords protection within a circular space equal to double its length.

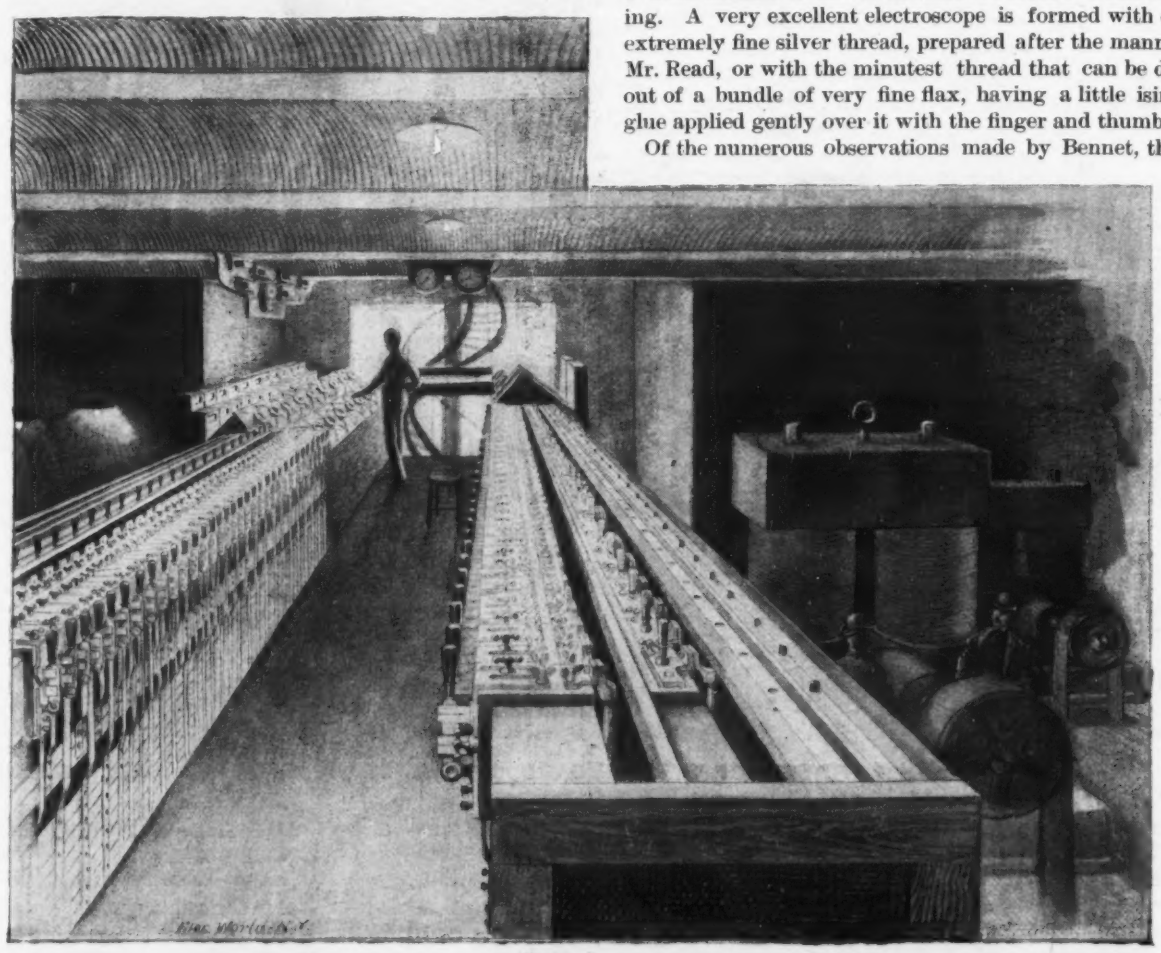


FIG. 3.—FIREPROOF SWITCHBOARD OF THE TWENTY-SIXTH STREET EDISON STATION, NEW YORK CITY.

Charles invented the megascope and was the first to make an ascension in a hydrogen balloon, which he did in company with Mr. Robert on the 1st of December (not on the 2d of August), 1783, ten days after the first trip made by Pilatre de Rozier and Comte d'Arlandes in a Montgolfière from the Paris Bois de Boulogne.

See "Biographie Générale," vol. IX., pp. 929-933; Larousse, "Dict. Univ.,vol. III., p. 1,020; *Journal de Physique* for 1791, p. 63; "Mémoires de l'Acad. des Sciences" for 1828; George Adams, "Lectures on Nat. and Exp. Philosophy;" London, 1799, vol. III., pp. 462–464; "Franklin in France," 1888, Part II., pp., 256, 270, 276–280; M. Veau Delaunay, Introduction to his "Manuel, etc.," Paris, 1809, pp. 19, 25 and 61–63, also pp. 23, 68, 92, 96, 122, 176 and 214.

A. D. 1787.——Mann (Théodore Augustin) Abbé, Flemish writer and antiquary, becomes perpetual secretary of the Brussels Academy of Sciences, ten years after leaving the Nieuport Monastery (1777), and is charged with the duty of making meteorological observations, which are regularly transmitted to the Mannheim Academy, who receive similar reports from different parts of Europe and publish them under the title of "Ephémérides Météorologiques."

His many investigations made with electrical machines are embraced in the last named publication and are also alluded to in his "Marées Aériennes, etc.," which appeared in Brussels during the year 1792.

See "Biog. Générale," tome XXXIII., page 231; Larousse, "Dict. Universel," tome X., page 1,085; *Phil. Mag.*, vol. IV., page 337; "Comm. Ac. Theod. Pal.," 1790, vol. VI., page 82.

A. D. 1787.——Bennet (Rev. Abraham), F. R. S., first describes in the *Philosophical Transactions* for this year, pages 26–32, the gold leaf electroscope which bears his name and which is the most sensitive and the most important of all known instruments for detecting the presence of electricity. It consists of a glass cylinder which is covered with a projecting brass cap, made flat in order to receive upon it whatever article or substance is to be electrified, and having an opening for the insertion of wires and of a metallic point to collect the electricity of the atmosphere. The interior of the cap holds a tube carrying two strips of gold leaf, in lieu of the customary wires or threads, and upon two opposite sides of the interior of the cylinder are pasted two pieces of tin foil directly facing the gold leaf strips. The cap is turned around until the strips hang parallel to the pieces of tin foil, so that any electricity present will cause the strips to diverge and make their lower ends strike the tin foil, which will carry the electricity through the support of the cylinder to the ground.

The gold leaf electroscope of Mr. Bennet, says Wilkinson, possesses great sensibility, and through the improvement of Mr. Pepys, by which the coatings are rendered movable, very small portions of electricity are discernible. The instrument is so delicately constructed as to be readily destroyed. Even in drying the outside of a glass, so great a disturbance of the fluid will be occasioned that the leaves will adhere to the glass in such manner as not to be removed from it without tearing. A very excellent electroscope is formed with either extremely fine silver thread, prepared after the manner of Mr. Read, or with the minutest thread that can be drawn out of a bundle of very fine flax, having a little isinglass glue applied gently over it with the finger and thumb.

Of the numerous observations made by Bennet, the following interesting extract relative to the phenomenon of evaporation is taken from the *Philosophical Transactions* for the year 1787. "If a metal cap with a red hot coal in it be placed upon the cap of a gold leaf electroscope, a spoonful of water thrown in electrifies the cup resinously; and if a bent wire be placed in the cup with a piece of paper fastened to it to increase its surface, the vitreous electricity of the ascending column of vapor may be seen by introducing the paper into it. The experiments on the evaporation of water may be tried with more ease and certainty of success by heating the small end of a tobacco pip and pouring water into the head, which, running down to the heated part, is suddenly expanded, and will show its

* Continued from THE ELECTRICAL WORLD of Dec. 19, 1891.

electricity when projected upon the cap of the electrometer more sensibly than any other way that I have tried. If the pipe be fixed in a cloven stick and placed in the cup of one electrometer while the steam is projected upon another, it produces both electricities at once.

Some of Mr. Bennet's experiments with the electroscope on the electricity of sifted powders, upon the electricity of the atmosphere, etc., are recorded at pages 564 and 566 of the "Britannica," vol. VIII., and at page 56 of "Library of Useful Knowledge."

Mr. Bennet also invented the *electrical doubler*, designed to increase the small quantities of electricity by continually doubling them until visible in sparks or until the common electrometer indicates their presence and quality (*Phil. Trans.* for 1787, page 288). It consists of three plates of brass, illustrated and explained at Fig. 9, page 20, vol. I., of Prescott's "Electricity and the Electric Telegraph," 1885 edition, wherein it is stated that in forty seconds the electricity can thus, by continual duplication, be augmented five hundred thousand times. (See, for Doublers, C. B. Désormes and J. N. P. Hachette, in *Annales de Chimie*, vol. XLIX., for 1804, *Phil. Trans.* for 1794, page 266; Sir Francis Ronalds, "Edinb. Phil. Journal," vol. IX., pages 323–325.)

At page 105, I. and II. of his "Rudim. Magnetism," Snow Harris mentions the fact that, in some of his experiments, Mr. Bennet employed a magnetic needle suspended by filaments of a spider's web as a magnetometer. In this connection, it may be said that, in the *Philosophical Transactions* for 1792, the assertion is made that a fine and weakly magnetic steel wire suspended from a spider's thread of three inches in length will admit of being twisted around eighteen thousand times and yet continue to point accurately in the meridian, so little is the thread sensible of torsion. (Young's "Course of Lectures," 1807, vol. II., page 445.) The use of the spider's line had, during the year 1775, been recommended as a substitute for wires by Gregorio Fontana, who, it is said, obtained threads as fine as the eight thousandth part of a line. In a lecture delivered at Boston, Mass., during the year 1884, Prof. Wood alluded to spider's threads estimated to be one two-millionth of a hair in thickness.

See A. Bennet, "New experiments on Electricity, etc.," Derby, 1789, and "A new Suspension of the Magnetic Needle, etc.," London, 1792; Introduction to "Electrical Researches" by Lord Henry Cavendish; *Sc. Am. Supplement*, No. 647, p. 10, 327; Noad, "Manual," p. 27; Cavallo, "Nat. Phil.," 1825, vol. II., pp. 199, 216; *Phil. Trans.*, vol. LXXVII.; *Sc. American*, vol. LI., p. 19; *Annales de Chimie*, vol. XLIX., p. 45; E. Walker (*Phil. Mag.*, vol. XLI. p. 415).

Electricity in Mining.—V.

Having considered the special applications of electricity to mining devices, we now come to that large group which embraces such universal requirements as lighting, pumping, ventilating, etc. Nearly, if indeed not all, of these are absolute necessities in all departments of mining without regard to locality or conditions. Therefore, in considering them we must assume that other mediums than electricity have heretofore supplied the necessary power or light, as the case may be.

FIG. 1.—THE ELECTRIC LIGHT IN A COAL MINE.

LIGHTING.

A combined arc and incandescent electric plant affords the ideal lighting system for large mines. A few arc lamps are both economical and essential for surface lighting, while the incandescent lamp affords the only safe illumination for underground work. Now that the practice of burning arc lights on incandescent circuits is an accomplished fact, such an equipment would not necessitate a special arc light dynamo, the incandescent one alone being sufficient.

The light-giving filament of the incandescent lamp is encased in a hermetically sealed glass chamber, making contact with the air impossible, so that in case of a lamp being accidentally broken the filament is instantly destroyed, and there is no possible chance of an explosion occurring. The flexibility of the electric conductor allows of the placing of the light in all sorts of positions, and admirably fits it for the constantly changing requirements of modern mining work. Its element of safety removes the uncertainty of life from explosions, which has been such a serious detriment to mining work in the past. The copper conductor conveying the light-giving energy is cold and motionless, and can be laid in any direction and at any distance from the generator up to several miles.

On the score of economy it is only necessary to call the attention of mine owners to the fact that there are now burning in the United States 5,200,000 incandescent lamps, and the number is constantly increasing. These figures must be considered with the fact that the price of gas has of late been greatly reduced, and the electric light has had to fight its way inch by inch against its older rival. Again, the electric lights may receive their current from the circuits which supply power to the electrically driven machines, and avoid any extra installation for their special account.

Fig. 1 gives a good idea of the value and convenience of incandescent lights at the foot of a mine shaft. Being permanently fixed in position, the work can be continuously pushed, accidents avoided and the health and comfort of the miners greatly increased.

Following will be found a partial list of the mines at present lighted with this most improved artificial illuminant. This is very remarkable for the short time that electricity has been recognized as a factor in mining work.

Copper Queen Mining Company, Bisbee, Ariz.; another mine of the same company at Fairbank, Ariz.; Union gold mine, San Andreas, Cal.; Grover Mining Company, Amador City, Cal.; The I. S. Halsey mine, Tin Cup, Colo.; May Flower mine, Idaho Springs, Colo.; Caroline Manufacturing Company, Ouray, Colo.; Saratoga Mining Company, of Ouray, Colo.; Edward G. Stroiber mine, Silverton, Colo.; Aspen Mining and Smelting Company, Regent mine, the Aspen mine, Taylor & Brunton, and the Aspen Public Tramway Company, all of Aspen, Colo.; the Mary Murphy Mining Company, Bromley, Colo.; Commonwealth Mining Company, Idaho Springs, Colo.; the Michael Breen Mining Company, Ouray, Colo.; the Ouray mines, Breckenridge, Colo.; Himrod & Hudson, Idaho Springs, Colo.; Tiger mines, Burke, Idaho; the Helena and Frisco Mining Company, Gem, Idaho; the Bunker Hill and Sullivan Mining Company, Warden, Idaho; Conglomerate Mining Company, Lan La Belle, Mich.; Superior Mining Company, Ironwood, Mich.; Centennial Eureka Mining Company, Eureka, Utah; the Dominion Mineral Company, Sudbury, Ont.; Brown Bear Mining Company, Deadwood, S. Dak.

PUMPING.

Perhaps the most essential contrivance in the equipment of a mining plant is the pump, for, unfortunately, the presence of water in the mines is one of the principal difficulties to be contended with. The possibility of a sudden inrush of water is an ever-present danger to the miner, as many great calamities in the past fully attest. In such cases the water generally flows in such a volume as to make the immediate use of a pump absolutely necessary, as the following incident will show. In the mine of the Pancoast Coal Company, during their work last year, a "dip" in the mine was struck, and the outflow of water was more than 20 men could bail. In desperation the company was about to put in a steam pump, when, happily, the electric pump was thought of. An ordinary Goulds pump, operated by an electric motor, was brought into service, and the place cleared of water in 30 hours. The "dip" was more han 3,000 feet from the shaft, and the expense of placing and running the pump for four months proved to be less than the cost of the steam pipe at the head of the shaft.

The motor in electric pumps forms an integral part of the machine. It is mounted on the same bed plate, and is usually protected from water and dampness by special insulation. Having the pump thus complete within itself, all that is necessary is to place it wherever required. This may be 100 or 5,000 feet from the shaft, the distance to which the electric current can be economically transmitted being almost anything that is required in mining work. The water-proof conductors are laid from the generator, connections are made to the pump, and that is all the miner has to do.

A large electric pump is now at work in the Grover Mining Company's mine, at Amador City, Cal. This pump is located 3,000 feet from the generator and has been in successful operation for a long time. Pumping away silently and without interruption day after day, this single electric equipment speaks volumes for the value and convenience of electric pumps in mining work.

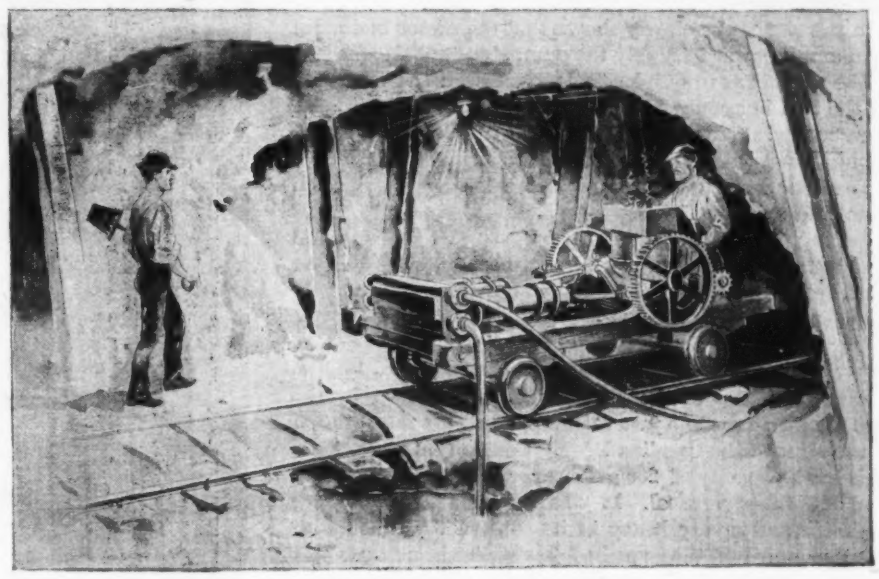


FIG. 2.—PORTABLE MINING PUMPS.

At Willock Station, Pa., a small centrifugal pump is operated by a 3-h. p. Tesla motor, both fastened to a truck, so that they can be moved to any part of the mine. This arrangement brings out another valuable feature of the electric pump, as it enables the miner to use much smaller appliances than would otherwise be necessary in mines not troubled with much water at any one place. In many cases it also makes costly water-ways to collect the water in one "sump" unnecessary.

By a very simple system of drainage the water can be collected into "sumps" dug at convenient points. An electric motor mounted on a truck, as shown in Fig. 2, can then be run to these different points of collection, and free the mine from the water thus gathered. This is not only a great saving in the cost of equipment itself, but also in the item of labor, as one man can easily handle the pump.

The pump shown in Fig. 2 is the new horizontal Goulds triple pump. This company is now making two sizes of these pumps, having cylinders 4 by 6 and 5 by 6 inches respectively. The latter size has proved more generally useful than the former. Other types of the well known Goulds pump are also being equipped with electric motors.

At Peale, Pa., a very successful pumping plant has been installed by the Wenstrom Electric Company, consisting of an 8-h. p. compound dynamo and a 5-h. p. motor geared direct to a Goulds rotary pump. The generator is placed in a small power house just outside of drift No. 9 of the Grass Flat mine, and from it weatherproof insulated wires are taken into the mine, passing through the airway and being attached to porcelain insulators. Wherever the wires cross headings (or side entries), they are taken through iron pipes. Taking the very damp condition of the mine into consideration, it cannot be said that the use of porcelain insulators is the best practice. Instead of these glass insulators of the usual pattern should have been used, and wherever the wires pass through the tubes they ought to be protected by the very best insulation. The pressure at the dynamo is 125 volts, and when the pump is worked to its full capacity the motor takes 28 ampères. The latter is 3,000 feet from the generator and runs at a speed of about 500 revolutions. This pump has a capacity of 15,000 gallons of water per hour.

The suction pipe is five inches inside diameter and 120 feet long, and has a lift of eight feet with a knee over the sump. The outside pipe is four inches in diameter by 400 feet long and has a lift of fourteen feet with one slight bend. The water from the different headings is gathered into a "sump" capable of holding about 12,000 gallons. The pump is run to its full capacity until all the water is pumped out, resting then until the "sump" is again filled. This plant was put in in preference to sinking two shafts 100 feet deep and placing steam pumps with their appliances inside the mine.

Perhaps the largest electric pump now in operation in any mine is the one at the Poorman mine, Burke, Idaho, shown in Fig. 3. This is known as the Knowles improved electric duplex outside packed plunger mining pump. It has two 29½-inch diameter water-plungers with 12-inch stroke. Its capacity is 500 gallons of water per minute to

an elevation of 500 feet vertical. It is operated by a 100 kilowatt Edison motor.

This remarkable pump was tested at the Schenectady Works of the Edison General Electric Company before being sent to the mines, with the results given in the table below :

The pump was arranged in such a way that the four 9½ by 12 pressure cylinders took their suction from a large tank and discharged back into same through a throttle discharge valve, making an additional head of ten feet to reading of gauge. The two 10 by 12 tail cylinders took their supply from the same tank and discharged independently into this tank, making a head of 7 feet.

In starting pump a 75-h. p. rheostat, 150 ampères, was used, and when under full speed this rheostat was cut off and the full current turned on to the engine. The motor was a 100 kilowatts, 85 type motor, wound for 250 volts and 400 ampères.

In the test it was clearly shown that the motor had more than ample power to supply the pump.

The pump was run under various pressures as indicated by the test, but could not be made to run against more than 300 lbs. pressure from the cause that there was not enough power at the power stations to supply same.

The details of the test will give the necessary information as to efficiency, etc.

Taking the efficiency from the table as 83.6 per cent. and making an allowance of 3 per cent. for slip, gives 80.6 per cent. for the efficiency of pump and motor combined.

Power required to run pump with no pressure on gauge...	15.8 h. p.
Work of pump.....	2.36
Power required to run pump when doing no work.....	13.4 h. p.

Another pump of the Knowles pattern, known by the same name as the one just mentioned, is now in operation at the mine of the Carolina Mining Company, Ouray, Colo. This has a capacity of 200 gallons per minute to an elevation of 300 feet vertical. It was designed especially for high lifts and is very heavy in its construction, the motor being mounted on the same bedplate with the pump. This arrangement makes the apparatus self-contained and capable of being placed in cramped quarters.

Still another very large mining pump of the same type is now working in the Hamilton ore mines in Michigan, being operated by a Thomson-Houston motor. This has a capacity of 150 gallons per minute to an elevation of 1,500 feet in one lift.

It may be said that the type of pumps we have thus far mentioned belong to the permanent equipment of the mine, that is, after operations have been established beyond a doubt and the work is to continue. Before this state of affairs is realized, however, much temporary work must be done, especially preliminary drainage. The apparatus for this work must of necessity progress with the sinking of the shaft, and it is in this connection that the electric pump is unqualifiedly the most preferable.

The steam pump has heretofore been used for this work, having driven other arrangements out of practice. Its equipment, however, necessitating as it does a special steam hoist, steam-piping for the suction and discharge pipes, as well as the extremely rigid character of the plant, cannot at all compare with the simple flexible electric conductors and small motor of the electric pump. The latter arrangement also increases the miner's capacity for work 40 per cent. by removing the obnoxious exhaust steam which makes life in confined spaces almost intolerable.

MINE MILLING.

It is not necessary to discuss here the great superiority of electricity as a means of transmitting energy as compared with other methods; but it will be timely to now consider some of its advantages in mine milling work.

Instead of heavy shafting, large belting and necessary loss of power in counter shafting, consequent in former methods in the conveyance of energy, there comes the use of individual motors with little or no belting, and connecting directly, in a majority of cases, to the machine operated, without countershafting, giving a much greater efficiency and a greater mobility in the control of power.

Electrical transmission enables the mine manager to locate his mill directly at the mine shaft. The quick recovery of energy released on the line of circuit, with ability to use it miles away in another direction enables him to successfully utilize cheap primal energy of much less horse power. At the same time, as in the small distributed horse powers used—for instance, in the Frue vanners at the mine mill—the motion is, by the automatic action of the motor, kept perfectly uniform, and the speed of the belt, laterally, being once adjusted in conformity with the inclination and the material worked upon, is kept absolutely regular.

Edison Electric Drill at Work at Syracuse, N. Y.

The same advantages are gained in the application to all classes of mining machinery. The ability, without large expense and loss of power, to operate single machines, if required, throughout the mine mill, is of great value; and such a distribution of energy in small units obviates many of the difficulties that come from belting to a common line of shafting, and which often gives, in connection with the sensitive machines, like the ones we have illustrated, great irregularity of motion, and therefore very unsatisfactory results in operation.

These advantages pointed out are fast becoming recognized in mining circles. Crushers, separators and other milling machine plants are already at work in different parts of the country. In subsequent issues of The Electrical World some of these interesting plants will be described, showing that the electric current has touched every branch of modern mining.

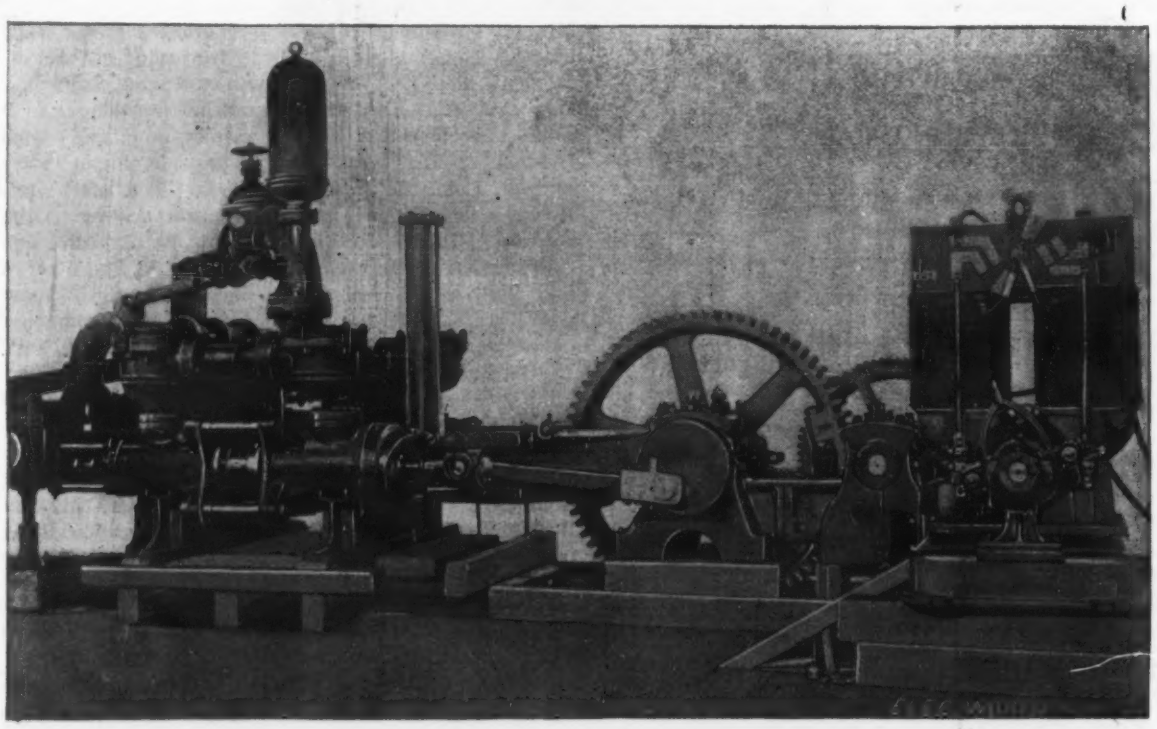


FIG. 3.—EDISON-KNOWLES ELECTRIC MINING PUMP OF 100 H. P. CAPACITY.

TEST OF 9½ × 12 DUPLEX, OUTSIDE CENTRE-PACKED PLUNGER ELECTRIC POWER PUMP FOR POORMAN MINE, BURKE, IDAHO.

	Average per minute.		Galls. per minute by plgr. displacement.		Gauge reading.	Mechanical h. p.			Volts.	Amperes.	Watts.	Electrical h. p.	M. h. p. E. h. p.
	Revolutions of pump.	Revolutions of motor.	Tail pump.	Main pump.	Water pressure.	Tail pump.	Main pump.	Total.					
Averages.....	38.4	512	609	523	230	1.08	71.47	72.55	235	277	64,999	87.1	.836
3-hour run.....	38.	494	597	513	230	1.06	70.10	71.16	236	270	63,720	85.4	.833
*1-hour run.....	38.5	500	605	520	300	1.08	92.24	93.32	250	320	80,000	107.3	.870
Special.....	38.	494	597	513	....	1.06	1.30	2.36	236	50	11,800	15.8	.149

* Pump running under same conditions as during tests, but without any pressure on gauge.

Electric Drill Plant.

The uses to which the electric drill is being applied embraces not only mining work but all features of quarrying, as will be seen by the illustration herewith. This view is made from a photograph of one of the Edison electric percussion drills now in operation at Syracuse, N. Y., in the works of the Solvay Process Co. Here two of these drills have been boring holes for blasting on an extensive scale, and are giving excellent results. The drill, as shown, is now working several hundred feet from the power house, and is easily handled by one man.

Elements of Practical Electricity.*

BY DR. LOUIS BELL.

We have defined already the unit current to be that unit length of which at unit distance from the unit magnetic pole will attract or repel that pole with unit force.

Now as to the unit pole, it has already been defined in a similar way. Since we now know the unit force as compared with the pull of a known weight, we could if necessary determine by a process of weighing the strength of a magnetic pole ; to do this it will be necessary to take a very long and thin magnetized steel wire, for, as you can readily determine by a few experiments, the longer a magnet is in proportion to its diameter the more nearly can we consider it to possess definite poles; that is, the more nearly is the magnetic force centred at the ends.

If, now, such a magnetized wire were broken in the centre you would find developed at the break two opposite poles of equal strength. By weighing the attraction between these when just one centimetre apart, you will obtain the measure of their strength. This it is almost impracticable to do on ordinary scales; it can be best accomplished by means of a very delicate spring balance, or, still better, by a device which we shall have to describe later, known as the torsion balance. At one centimetre distance between the poles a milligramme of attraction would correspond to the unit pole, two milligrammes to a pole possessing two units strength, and so on.

We could thus obtain a magnet having poles of known strength, and with these we could by a similar process measure by actually weighing the strength of a current in the following way: Fig. 29. Our magnet would be very long and slender, suspended from one arm of a delicate balance, and counterpoised by weights placed in the scale pan on the other end of the balance arm. Suppose that the lower north pole of this magnet has been found to be of unit strength; then the wire carrying the current would be most conveniently arranged in the following way: It should be bent into a circle of unit radius so that every part of it may be at unit distance from the centre where the magnetic pole is to be placed. The end of the suspended magnet would be placed directly at the centre of this circle, a current passed through the latter and the attraction or repulsion measured by the ordinary process of weighing; then if unit current were flowing through the ring each centimetre of that ring would exert unit force upon the magnet pole; the circumference of the circle would be—since its radius is one centimetre—6.28 centimetres; therefore there would be acting upon the pole 6.28 unit lengths of current.

The result would be an attraction or repulsion, according to the direction of the current, of almost exactly 6¼ milligrammes for unit current; or, knowing the strength of the pole in terms of the system of measurement we have been using and knowing the radius of the circular current that acts upon it, we can, by weighing the attraction produced, find out exactly the strength of the current in terms of our fundamental units of measurement.

It would be inadvisable for you to try these experiments of weighing, as they require better apparatus and more experimental skill than most people possess, and besides that there are ways—which will be explained later—of performing virtually the same experiments in a great deal simpler and more accurate manner. You can see, however, from such experiments, what unit current really means, and how it can be measured in terms of the magnetic force produced.

For this C. G. S. unit current there is no specific name: it happens to be rather large compared with most of the currents with which people had to do some 20 years ago when the system was devised, hence one-tenth of this current has been taken as the practical unit and is given the name of one "ampère" in honor of the distinguished French investigator to whom is due much of our knowledge of the fundamental properties of electric currents.

* Continued from The Electrical World, Dec. 19, 1891.

We have, then, found our practical everyday unit of current, the ampère, to be derived directly from the units of force and of length, and that it bears a very simple relation to them; it therefore becomes comparable with other quantities measured in the same convenient C. G. S. system.

We have already noticed that it would be possible to measure current in terms of its power of, for example, depositing copper from a solution. A great many experiments have been carried out to determine exactly the amount of copper and other metals which one ampère of current—as defined above—will deposit in a given time, so that current in ampères can be handily measured either directly or by its chemical effect, as may be most convenient at the time.

The currents are measured in ordinary galvanometers by their magnetic action, but in other cases the electrolytic effect may be more available, and it is utilized on a large scale in the Edison electric meter for measuring currents applied to incandescent lamps.

The result of the experiments above mentioned is that one ampère of current will deposit from a properly made solution 1.118 milligrammes of silver per second and .326 milligramme of copper. We shall see next how this study of the unit of current can be applied to practical purposes by means of the ordinary galvanometer, and how some other important electric units are connected to that of electrical current.

To make use of the galvanometer for practical work you must, evidently, find out what deflection corresponds to a given current measured in ampères. Going back to the point where we, before constructing the galvanometer, discussed the action of the magnetic force of the solenoid on the suspended needle in opposition to the earth's magnetism, we found that when the needle was in equilibrium,

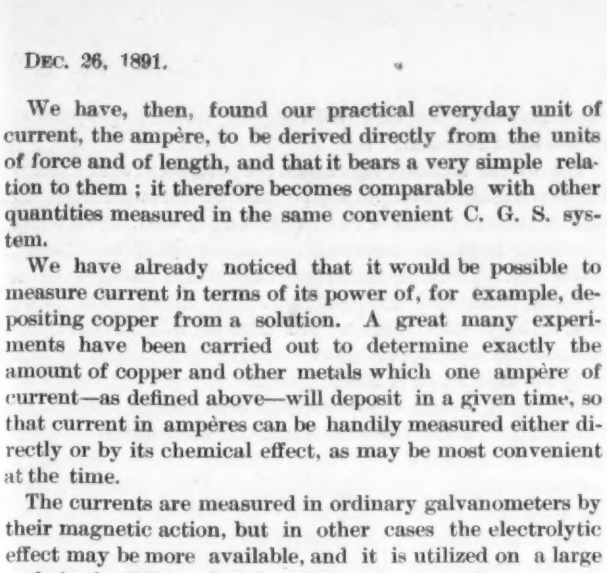


FIG. 29.—WEIGHING THE ELECTRIC CURRENT.

F, the magnetic force we desired to measure, equaled *H* tangent *A*. Now it is evident from what we have just seen about the attraction of a wire carrying a current for a magnet that the effect of such a wire in producing magnetic pull will depend on its length, and also on its distance from the magnet upon which it acts. What we want to find out about our galvanometer is the relation of the current to the magnetic force and consequent deflection which it produces. For any given galvanometer where the relative position of the needle and coils is always the same and the length of the coils invariable, the force produced, in any magnetic units we choose, must be some whole or fractional number of times the current in ampères. In other words *C*, the current, equals *K F*, therefore in terms of the earth's magnetism and the deflection of the needle *C* equals *K H* tangent *A*.

As *H* for any one place is very nearly constant itself, we might include it in *K*, so that the current would then be simply equal to a certain number of times the tangent of the angle, but it is a little more convenient to keep in mind the fact that *H* has an existence by itself, and to find, by some means or other, the value of the product *K H*. If we once know this we can then immediately find any given current that is passed through the galvanometer in ampères, by multiplying *K H* into the tangent of the angle of deflection. If, for example, the value of the product *K H* should chance to be 2 and the deflection was 35°, the tangent of which is .7, the current in ampères would be 1.4. This would correspond to an unusually sensitive tangent galvanometer.

To measure current in ampères by means of our galvanometer, we want to find the value of the product *K H*. Since this remains constant for the same galvanometer at the same place, if we can in any way pass a measured current through the galvanometer and note the deflection, we can find the value of *K H* once for all, because *K H* always equals the current in ampères divided by the tangent of the angle of deflection. This relation is known as finding the galvanometer constant, more properly the "reduction factor." Since the galvanometer constant proper, *K*, is determined by the size and number of the coils of wire, the other part of the reduction factor being the earth's magnetism constant *H*, the simplest way of finding the constant of your galvanometer is to pass a current around the coils, measuring its amount either by another galvanometer whose constant is known, or by a galvanometer constructed to read ampères directly. Such instruments are known as ammeters.

At the present day you will usually find it not a difficult matter to borrow an ammeter long enough to make the measurement, or else to take your galvanometer to some point where such an ammeter is available. In either case the ammeter—which generally contains magnets—should be kept far from the galvanometer, and the galvanometer itself should not be brought near any iron where it is being compared, because the presence of any considerable quantity of iron affects the earth's magnetic field at that point.

Supposing you are able to obtain a galvanometer of known constant, or ammeter, you have simply to connect it in series with your galvanometer, find the current from the ammeter reading, or the constant and deflection of the instrument with which you are making comparison, note the deflection on your own galvanometer and divide the current by the tangent of that deflection, you will then have the product *K H* for future use; and it is only necessary then in measuring current to pass it through your instrument and multiply the tangent of deflection by that value of *K H*, and you at once have the current in ampères.

You must remember, however, in making such comparison not to use too strong a current, as, in the first place, the wire with which your galvanometer is wound will heat severely if more than five or six ampères is passed through it, and, second, because you do not want too large a deflection, for as the deflection approaches 90 degrees the tangent varies with great rapidity, so that a very small error in reading the deflection may make a large error in finding *K H*. The current from your two Daniell cells in series will generally be fairly well adapted for the purpose of comparison.

In case no ammeter or good galvanometer is available, but you are able to obtain the use of a pair of apothecaries' delicate scales, you can fall back on the electrolytic method of determining the current. Or, in default of that, on one or two rough approximate methods, which will be described presently. As the determination of current by the amount of copper deposited from the solution in a given time is a rather delicate operation, we reserve the description of the practical precautions that must be taken until the next article.

Measurement of the Power Developed by Alternating Currents in Any Circuit.

BY CARL HERING.

Some months ago there appeared in these columns some very good articles on the measurement of power generated by alternating currents in a circuit having induction, such for instance as that of a transformer. These articles appeared to contain a considerable amount of mathematics, and were, therefore, doubtless passed over by quite a number of electricians who may have wished to apply these methods. Beside this, the original article was followed by a discussion, the results of which were quite interesting and useful. For the benefit of those who have not the time to sift out the ultimate conclusions the following abstract has been prepared, accompanied by examples, which we hope will bring the method within the reach of the many who would like to use it, but have not time to make the abstract for themselves.

Before describing these methods, it may be well, for the benefit of those who have heretofore worked only with continuous currents, to explain why it is that there should be any more difficulty in measuring power generated by

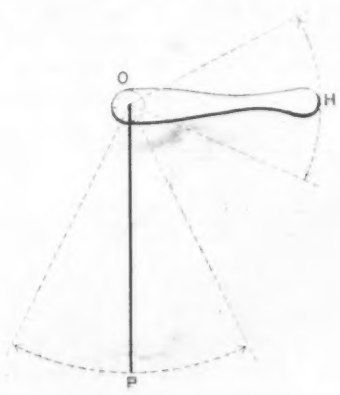


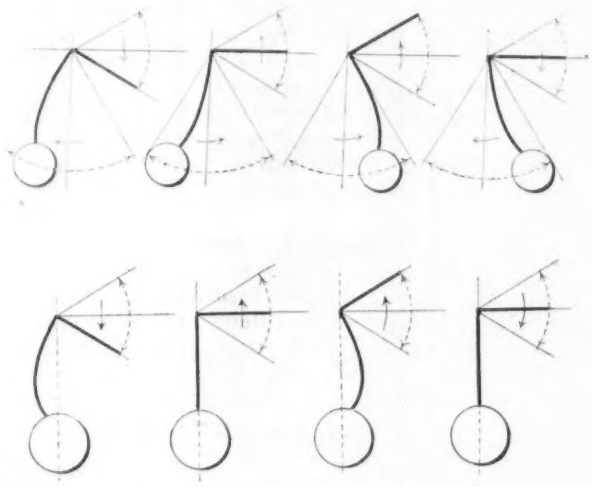
FIG. 1.—MEASUREMENT OF POWER DEVELOPED BY ALTERNATING CURRENTS.

alternating currents than when generated by a continuous current, a point which is probably not clearly understood by many.

Every one knows that to calculate the power generated in any continuous current circuit we have only to multiply the current by the voltage, or the square of the current by the resistance, or divide the square of the voltage by the resistance; but this law, like Ohm's law, does not always apply to alternating current circuits. The reason is, that the waves of the current and of the voltages do not coincide; one lags behind the other, and therefore we can not multiply their mean or their maximum values together. Mathematicians tell us that we have only to multiply their product by the cosine of the angle of the lag, to get the true results; but this rule may cause considerable mischief in the hands of any one who does not understand it thoroughly.

The action of these alternating currents and voltages, and the way in which it differs from those of continuous currents may perhaps be more easily understood by those who are familiar only with continuous currents by the following simple analogy in mechanics. Any one will be able to understand the mechanical analogy and we therefore hope that the somewhat similar action of alternating currents will be rendered more clear. This analogy is not a perfect one, that is, it is not in every way the equivalent of the electric phenomena, but it is sufficiently similar to enable one to form a sort of picture of the action.

Referring to Fig. 1, let *O P* be a flexible pendulum, made, we will say, of a stiff, flat steel spring; let *O H* be a handle connected to the top of the pendulum and pivoted at *O*. By means of the handle *H* let this pendulum be moved rapidly to and fro through an angle as shown. Suppose the pendulum to be very light and the motions not too rapid, then it is evident that the motions of the pendulum will follow the motions of the handle at every instant, and will be in its extreme positions on the two sides at the same time when the handle is in its extreme position, or, in other words, the oscillations of the pendulum and those of the handle producing them will coincide in point of time. If, now, we imagine the motions of the handle to be analogous to the E. M. F. which produces a current, and if the spring of the pendulum be considered analogous to the resulting current, we have here an analogy to an alternating current when it is passed through a simple resistance having no inductive action, or having no electrical inertia, as it is sometimes called. In such a circuit the waves of the E. M. F. and of the current will coincide in point of time, that is, they will have a maximum at the same moment



FIGS. 2 AND 3.—MEASUREMENT OF POWER DEVELOPED BY ALTERNATING CURRENTS.

and they will pass through the zero point at the same moment.

Referring now to Fig. 2, let us assume that the end of the pendulum be weighted with a heavy weight, but still not heavy enough to bend the spring materially if it were held horizontally. Now suppose the handle *H* be oscillated as before, it will be seen from Fig. 2 that the bottom of the pendulum will not respond immediately to the motions of the handle; it will oscillate as before, but its motion will lag behind the motion of the handle. It will reach its maximum positions at different times than those at which the handle reaches its maximum positions; or, in other words, the two oscillating motions, although making the same number of oscillations per second, will not coincide in point of time: that of the pendulum will lag behind or follow that of the handle. In examining the four different positions shown, it will be seen also that there is a tendency to reverse the motion of the pendulum before it gets to its maximum positions, and that therefore the resulting motion of the pendulum will not be as great as it would be if there were no weight at the end. The action of this weighted pendulum is analagous to the action of an alternating current in a circuit having electrical inertia, as it is sometimes called; that is to say, having a something in the circuit which acts similarly to inertia in mechanics; that is, it will require a little time before the electromotive force which is applied really acts. The resulting motion of the end of the pendulum, as distinguished from that of the spring, may, to a certain extent, be said to be analagous to the resulting power of an alternating current; it will be greater and more nearly equal to that in Fig. 1, the less the inertia of the pendulum, or in the case of an electrical current, the less the amount of induction or electrical inertia which exists in the circuit.

We may go still farther with this analogy and illustrate a point which is sometimes difficult to understand. In Fig. 3, suppose the weight of the pendulum to be made very great, and suppose the oscillations of the handle are very rapid, it is easy to imagine that such a point may be reached that the moment the pendulum begins to move in one direction the motion of the handle has been reversed and will tend to move it in the other direction, so that the result will be that the pendulum remains at rest, although the motions of the handle are going on as before. This is

analogous to a theoretical case in which there is an electromotive force and a current, but there is no work done, the reason being that the waves of the electromotives forces and of the current are in opposite phases, or, in the language of the mathematicians, they differ from each other by 90 degrees, so that they neutralize each other in so far at least as they produce no effect in the way of work. It will be seen, therefore, in this analogy, that in case the pendulum is an appreciable weight, its motion, which we have said is analogous to the resulting power, is no longer dependent merely on the motions of the handle and the motions of the spring, but it depends also very greatly on its inertia, on its tendency to lag in the motion of the handle and the spring.

This same analogy may be carried still farther. It might be asked, what becomes of the power applied to the handle in Fig. 3, in which we have assumed that the pendulum itself does not move? It will be readily seen that in the mechanical analogy the power given to the spring at each oscillation is given back to the handle by the spring; in other words, it will be practically equivalent to simply bending the spring to and fro, in which case it is well known that no power is required except the small amount lost in the heating of the spring, which, as far as we are concerned at present, may be neglected. This case is similar therefore to a condenser in circuit of an alternating electromotive force. The electromotive force acts but does no work, as the current is given back again, neglecting, as we did above, the small amount lost in heating the condenser.

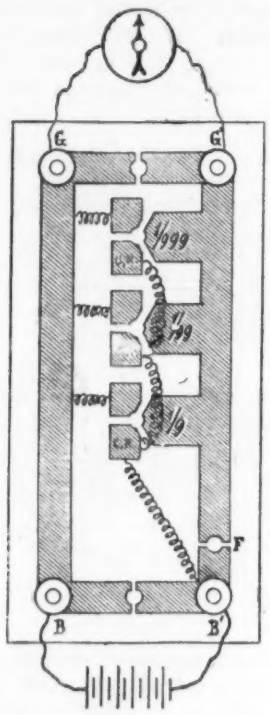


Fig. 1.—Galvanometer Shunts.

We may apply this analogy to still another point which is often difficult to understand. We are told that when a condenser or a Leyden jar is suddenly discharged, the discharge is of an oscillatory character, that is to say, the discharging current is an alternating current: also that these oscillations may be made less in number, and, in fact, may be prevented altogether, if a sufficiently great resistance is offered to the current. Referring again to Fig. 3, let us assume the pendulum to be in the second position, namely, at rest; now imagine the handle moved very suddenly to the next position, as, for instance, by a blow from the hand, and let it be held in that position. It will readily be seen that the pendulum in this case will follow the motion of the handle, but it will not come to rest suddenly, it will first oscillate to and fro for some time. This is precisely analagous to the oscillatory character of a current obtained from the sudden discharge of a Leyden jar. To continue the analogy, suppose the pendulum itself be placed in water, or in any liquid offering a mechanical resistance to its motion, it will readily be seen that the oscillations will then be much fewer in number. Finally, let us suppose the pendulum to be placed in a thick fluid like a heavy oil or glycerine, offering very great resistance to its sudden motion; in this case, when the handle is suddenly moved, the pendulum will follow, its motion will become less and less rapid, and it will stop at its ultimate position without passing it, that is, without first oscillating to and fro. In the same way a condenser discharged through a sufficiently high resistance will not generate an oscillatory current, but will generate a simple momentary current, which gradually dies out.

Having now illustrated why it is that in measuring alternating current powers we cannot multiply the current by the voltage, without considering other things also, the following abstract of the above-mentioned articles may, perhaps, be better appreciated by those to whom these subjects were not clear. The various methods given below were suggested by Messrs. Ayrton, Sumpner, Swinburne and Fleming. The proofs of the formulæ, together with further information, may be found in the original articles.

(To be continued.)

Compensating Shunts for Galvanometers.

When a galvanometer is connected in multiple with a shunt of definite proportional resistance, although the exact fractions of current which travel through galvanometer and shunt can be calculated, these two currents when added together will be found to be greater than the original current which flowed through the line before the shunt was introduced. This increase of current is owing to the extra circuit furnished by the shunt, for the introduction of the latter has practically the same effect as substituting in place

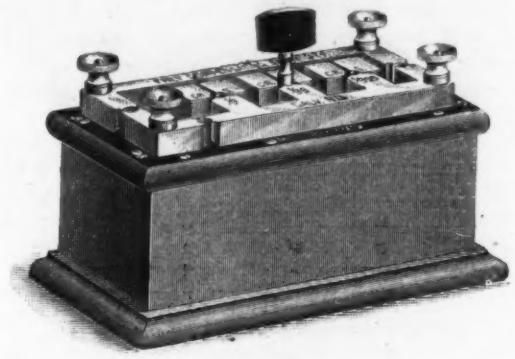


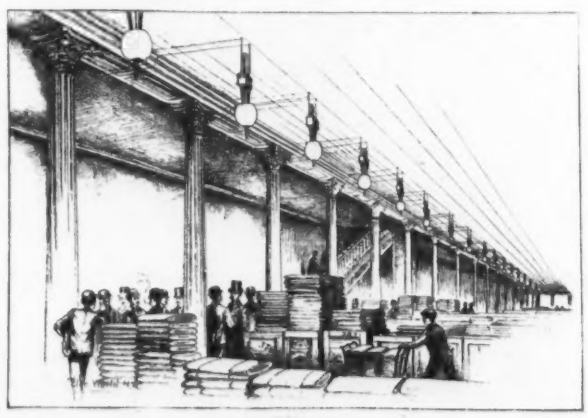
Fig. 2.—Galvanometer Shunts.

of the galvanometer a single conductor having a resistance equivalent to the combined resistance of galvanometer and shunt in multiple. Since any decrease in the resistance of a circuit results in an increase in current strength, the deflection secured by using a shunt will not be a true index of proportionate reduction in the galvanometer's sensitiveness, unless an extra resistance is introduced somewhere in the circuit which will reduce the current to its original amount. This extra or compensating resistance may be combined with the shunt used in such a manner that both may be introduced simultaneously. Figs. 1 and 2 illustrate a practical device of this character, the usual $\frac{1}{9}$, $\frac{1}{99}$, $\frac{1}{999}$ shunts being employed. In addition a compensating resistance having three branches is connected so that by inserting a single plug any one of the three shunt coils may be employed, the operation of introducing the plug throwing a suitable compensating resistance in circuit at the same time. When maximum sensitiveness is desired, the plug is inserted at *F* (Fig. 1). The current then travels directly to the galvanometer through the bus bars. Removing the plug entirely leaves the circuit open; placing it between *B* and *B'* short circuits the battery, and placing it between *G* and *G'* short circuits the galvanometer and leaves the battery open. This instrument is the invention of Mr. Charles P. Frey, electrician for The E. S. Greeley & Co., of New York.

Combined Arc and Incandescent Plant.

The advantages of an electric plant burning arc as well as incandescent lamps on the same circuit are well illustrated in the lighting of the largest dry goods house in the world, that of H. B. Claflin & Co., of this city. From the dynamo room to the farthest corner of the building the circuits of this plant supply both arc and incandescent lights wherever they are required.

Situated in the sub-basement is the dynamo room. Two No. 30 and two No. 50 Mather dynamos supply the necessary current. There are in all 241 10-ampère Ward arc lamps of 2,000-c. p. each and 600 incandescent lamps, the full capacity of the latter being 1,000. This installation replaced an old series arc light system of 125 lamps. For one of the four Mather dynamos a claim is made for a record for very long runs. It has been in continuous opera-



Combined Arc and Incandescent Plant.

tion for more than seven years, the commutator alone showing the effects of its long service. This, however, would only be noticed by close observation; as the portion worn away is not more than a quarter of an inch in depth. The dynamo is in good condition at the present time.

The switchboard of the plant is arranged against the side wall. It is a beautiful piece of work, being made entirely of marble. All connections with the instruments are made from the rear of the board. From here feeders are led to the different floors of the immense building, and these floors are provided with supply mains in proportion to the light required.

The wiring is something novel for interior work. Nothing is concealed, except where passing through walls, in which cases the interior conduit tubing is used. The wires supplying the lights are run on what are called the "Gem" insulators. These are small porcelain knobs fastened by a metallic band and arranged four feet apart. The wire used is the Bishop "White Core" and the arrangement presents a very neat appearance.

As is well known, the arc light is the only artificial illuminant that can be successfully used in dry goods houses to distinguish the various shades in the fabrics. Consequently in the large open rooms nothing but the Ward arc lamps are used. Their burning is absolutely constant, and the absence of all sputtering of the arc relieves the owners of anxiety as to fire. On the second floor there is a single line of 17 of these lamps extending the length of the building—380 feet. This is no doubt the longest line of low tension arc lamps ever installed. A good idea of their appearance may be obtained from the accompanying illustration. Certainly the presence of such a line of light in an establishment of this kind, representing 34,000 nominal c. p., is good evidence of the success of this kind of arc lighting. The offices, as well as packing rooms and cellars where the ceiling is low, are lighted with incandescent lamps.

The entire equipment, from the switchboard to the lamps, was installed by the Electrical Construction and Supply Company, of 18 Cortlandt street, this city, the instruments being supplied by the Mather company. Mr. F. G. Gibson, the chief electrician of the plant, deserves special credit for his intelligent supervision of the apparatus under his charge, forming as it does the most notable electric lighting plant in the dry goods district of New York, if not the most remarkable, for completeness, of any in the city.

On Polyphasal Generators.*

BY M. I. PUPIN, PH. D., COLUMBIA COLLEGE.

Few will deny the importance of the polyphasal current systems; none the fascination of their study. This belief induced me to present the following brief essay before the Institute.

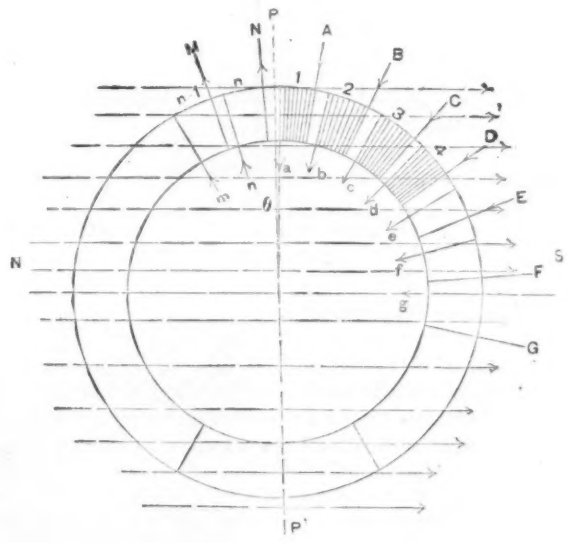


Fig. 1.—Polyphasal Generators.

The experimental researches in this new and promising field of electrotechnics are not yet numerous, but still the results already obtained are of so decisive a character as to leave no doubt whatever as to the extremely high practical importance which is attached to electrical generators, motors and transformers constructed according to requirements imposed upon us by this new method of combining a set of variable electromotive forces. For who among us does not thoroughly appreciate the beautiful inventions of Nikola Tesla, and the completeness of the success which Dobrowolsky and Brown obtained by the practical applications of these inventions?

The exact quantitative relations involved in the polyphasal system of currents are not, I venture to say, quite as well known as its practical results. To give an impulse to further inquiry in that direction is one of the principal aims of this modest investigation. For the present I propose to confine myself to the polyphasal generators in general, and particularly to polyphasal generators whose system of electromotive forces is capable of producing a rotary magnetic field of constant strength. The last point seems to me to be one of the vital points in this new method of electrical distribution. It is in this particular point that Mr. Dobrowolsky claims his system to be superior to that of Nikola Tesla.

Let us consider the theoretically simplest form of a polyphasal generator, as shown in Fig. 1. A non-magnetizable ring with *n* open equal coils at equal distances from each other rotates uniformly through a perfectly homogeneous magnetic field. Let *P P'* be the neutral plane of the field. At the instant when coil 1 is at the angular distance θ from

* A paper read before the American Institute of Electrical Engineers.

the neutral plane $P\,P'$ the E. M. F. generated in the various coils will be

$$e_1 = K \sin (\theta + \alpha)$$

$$e_2 = K \sin (\theta + \alpha + \frac{2\pi}{n}$$

....

....

$$e_n = K \sin \left\{ + \alpha + (n-1)\ \frac{2\pi}{n} \right\}$$

Where K is a constant depending, as is well known, on the field intensity, the speed of rotation, the number of turns in the coil and the area of the plane of a turn; α is the angular width of one-half of the coil.

Since

$$\sin (\theta + \alpha) + \sin \left\{ \theta + \alpha + \frac{2\pi}{n} \right\} + \ldots\ldots + \sin \left\{ \theta + \alpha + (n-1)\frac{2\pi}{n} \right\} = 0,$$

it follows that

$$e_1 + e_2 + e_3 + \ldots\ldots + e_n = 0. \qquad (1)$$

That is to say, the sum of electromotive forces generated in the various coils which are on one side of the neutral plane is numerically equal and of opposite sign to that of the coils on the other side of this plane. This result is well known and self-evident. It is, however, far from self-evident that relation (1), which I shall call the *relation of continuity* for the electromotive forces, will be satisfied by every magnetic field.

Close each coil separately by conductors of equal resist-

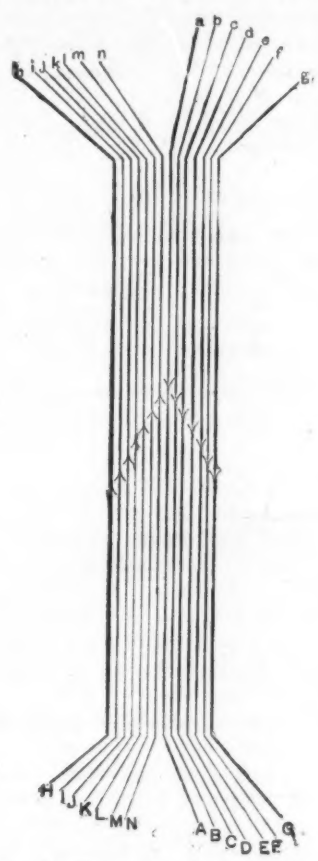


FIG. 2.—POLYPHASAL GENERATORS.

ance and self-induction. Let $c_1, c_2, \ldots\ldots c_n$ denote the currents in the n separate circuits. It is evident that

$$c_1 = \frac{K}{I} \sin (\theta + \alpha - \varphi)$$

$$c_2 = \frac{K}{I} \sin (\theta + \alpha + \frac{2\pi}{n} - \varphi)$$

$$c_3 = \frac{K}{I} \sin (\theta + \alpha + 2\,\frac{2\pi}{n} - \varphi)$$

$$c_n = \frac{K}{I} \sin \left\{ \theta + \alpha + (n-1)\,\frac{2\pi}{n} - \varphi \right\}$$

Where I is the impedanee in each circuit and φ the angle of retardation. Hence, we have

$$c_1 + c_2 + c_3 + \ldots\ldots + c_n = 0. \qquad (2)$$

That is to say, the relation of continuity is satisfied for the currents also.

Let the wires $aA, bB, \ldots\ldots nN$ (Fig. 2) represent a part of each of the n conductors of this system. Then, according to relation (2), the sum of the currents in these n linear conductors being always zero, if we joined them all into one conductor there would be no current in this wire, but the currents in the n circuits would circulate exactly the same as before. In fact, the common juncture is useless and can and should be cut out.

The diagram, Fig. 3, represents this method of connecting for a three-phase system. Consider, now, n equal coils distributed at angular distances of $\frac{2\pi}{n}$ over a laminated iron ring B, each coil being a part of the n conductors coming from the generator. Diagram Fig. 4 illustrates this for a three-phase system. Let the n currents be denoted now by $c_1', c_2', \ldots\ldots c_n'$. We shall have, now,

$$c_1' = \frac{K}{I} \sin (\theta + \alpha - \varphi')$$

$$c_2' = \frac{K}{I} \sin (\theta + \alpha + \frac{2\pi}{n} - \varphi')$$

$$c_n' = \frac{K}{I} \sin \left\{ \theta + \alpha + (n-1)\,\frac{2\pi}{n} - \varphi' \right\}$$

and, therefore,

$$c_1' + c_2' + \ldots\ldots + c_n' = 0. \qquad (3)$$

The introduction of the iron ring with the n coils into the n phasal system has changed the impedance I, and the angle of retardation φ; but this change is evidently the same for all coils. The correctness of this statement might perhaps be questioned, if we supposed that the system of the n variable currents was at any moment strong enough to saturate the iron ring, I therefore suppose that the intensity of magnetization in the ring is never over 10,000 C. G. S. lines of force. We shall presently see that in the

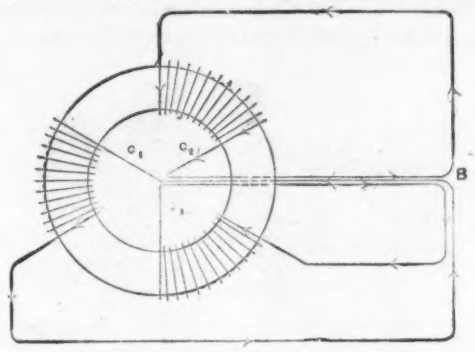


FIG. 3.—POLYPHASAL GENERATORS.

case of a properly built generator the saturation of the iron ring will not vitiate the correctness of the above statement in the slightest.

Let s be the number of turns in each of the n coils. Relation (3) gives

$$4\pi\, s\, c_1' + 4\pi\, s\, c_2' + \ldots\ldots + 4\pi\, s\, c_n' = 0. \qquad (4)$$

That is to say, the relation of continuity is satisfied by the magneto-motive forces.

Relation (4) translated into physical language means that the magnetization in the iron ring is due to two equal magneto-motive forces working in multiple arc. The magnetic field produced is perfectly symmetrical with respect to the ring, as indicated by the dotted lines in Fig 4.*

Consider now n iron ring cores of exactly the same dimensions and made of the same material. Let ρ be the reluctance of each ring. Let each of the n coils be interlinked with one of the iron rings; we shall have n homogeneous magnetic circuits and as long as the magnetization of these rings is considerably below the saturation point we shall have

$$\frac{4\pi\, s\, C}{\rho} + \frac{4\pi\, s\, C_2'}{\rho} + \ldots + \frac{4\pi s\, C_n'}{\rho} = 0.$$

That is to say the magnetic induction in the n magnetic circuits obeys the same law as the n electric currents; we can therefore employ the method of polyphasal connection for the magnetic circuits also and we obtain what the Germans call a Verkettung der Magnetischen Ströme, which may be translated into English by a more accurate expression: Polyphasal coupling of magnetic circuits. A transformer constructed on this principle may be called a coupled transformer.

A simple consideration will sho w that the field rotates around the axis of the ring B synchronously with the rotation in the generator which produces the impressed electromotive forces. Consider the armature of the generator. Since the ampère turns on one side of the neutral plane are always equal and opposite in sign to the ampère turns on the other side of this plane it is evident that the magnetic field due to the ampère turns in the armature is fixed in space and perfectly symmetrical with respect to the plane of symmetry PP^1. We can therefore say that this field, though *fixed in space, rotates with respect to the armature* with the *same angular* velocity with which the armature rotates in space. The distribution of the ampère turns over the stationary ring B being at any

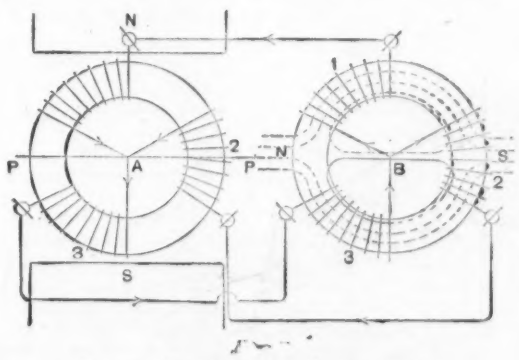


FIG. 4.—POLYPHASAL GENERATORS.

moment the same as that over the armature ring, it follows that the magnetic field of B also rotates with respect to B synchronously with the rotation in the armature. An inspection of the diagram in Fig. 4 will show that when the rotation in the generator is reversed the rotation of the field B will also be reversed.

The strength of the rotating magnetic field will vary because the strength of the two equal magneto-motive forces which are working in multiple arc will vary. The following simple consideration will show us the law of this variation. Two cases must be considered separately: First, when n is an odd number; second, when n is an even number.

*This will be always strictly true if we employ an even number of coils even when the number of phases is odd, because then distribution of the ampère turns is perfectly symmetrical.

CASE ONE.

A simple definition will save me the tedious repetitions of long sentences. I define the sum of all the electromotive forces generated in all the turns which are at any moment on the same side of the neutral plane of the generator as the resultant impressed E. M. F. at that moment. The magneto-motive force of the rotating field will evidently vary according to the same law as the resultant impressed E. M. F. To find the law of variation of the resultant impressed E. M. F. consider the armature of the generator when the angle Θ of coil 1 is zero. To make the reasoning shorter, I make now the angular width of each coil equal to $\frac{2\pi}{n}$, so that the n coils completely cover the ring, which makes $\alpha = \frac{\pi}{n}$. If this angular width is smaller, then a simple consideration will show that the law of variation which I am about to deduce will be exactly the same. In the position just mentioned, the coils 1, 2, 3, ... $\frac{n-1}{2}$ will all be on the same side of the neutral plane, whereas coil $\frac{n+1}{2}$ will be just half on one side and half on the other side of this plane. There is no electromotive force generated in this coil. As the above mentioned angle Θ begins to increase from zero, coil $\frac{n+1}{2}$ begins to contribute to the resultant impressed E. M. F., but this contribution is just counterbalanced by the loss due to the entrance of coil n into the opposite region of the neutral plane. The variation in the resultant impressed E. M. F. is therefore due solely to the change of position of the turns in the coils 1, 2, 3, ... $\frac{n-1}{2}$, or on one side and the corresponding turns on the other side of the neutral plane. This will be the case until coil $\frac{n+1}{2}$ has completely passed to one side of the neutral plane and coil

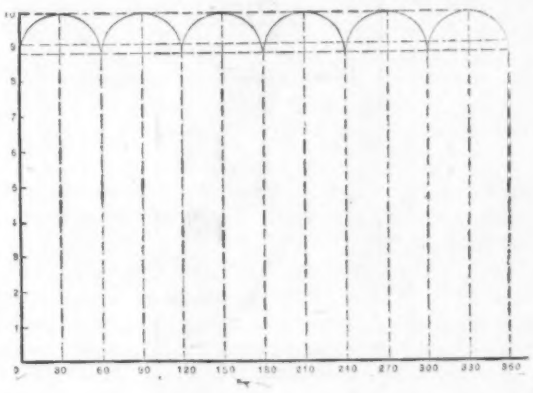


FIG. 5.—POLYPHASAL GENERATORS.

n is just bisected by it. During this interval Θ has increased from zero to $\frac{1}{2}\,\frac{2\pi}{n} = \frac{\pi}{n}$. The value of the resultant impressed E. M. F. at any moment during this interval is easily found. Denote it by E, then

$$E = e_1 + e_2 + \ldots\ldots e_{\frac{n-1}{2}}$$

$$= K \left\{ \sin (\theta + \frac{\pi}{n}) + \sin (\theta + \frac{\pi}{n} + \frac{2\pi}{n}) + \ldots\ldots + \sin \left\{ \theta + \frac{\pi}{n} + \left(\frac{(n-1)}{2} - 1 \right) \frac{2\pi}{n} \right\} \right.$$

$$= K \left\{ \sin (\theta + \frac{\pi}{n}) + \sin (\theta + \frac{\pi}{n} + \frac{2\pi}{n}) + \ldots\ldots + \sin \left\{ \theta + \frac{\pi}{n} + \left(\frac{n-3}{2} \right) \frac{2\pi}{n} \right\} \right.$$

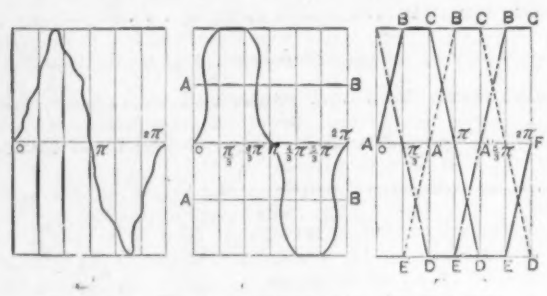
$$= \left\{ \frac{K_1 \sin (\theta + \frac{\pi}{n} + \frac{n-3}{4}\,\frac{2\pi}{n})}{\sin \frac{\pi}{n}} \right\} = K_2 \sin \left(\frac{\pi}{2} + \theta - \frac{\pi}{2n} \right) = K_2 \cos (\theta - \frac{\pi}{2n})$$

It is evident that the resultant impressed E. M. F. E varies during the interval from $\Theta = 0$ to $\Theta = \frac{\pi}{n}$ just like $\cos \left(\Theta - \frac{\pi}{2n} \right)$; that is to say, it varies just like a simple harmonic. When $\Theta = \frac{\pi}{2n}$, E reaches a maximum which is equal to K_2, it has a minimum both when $\Theta = 0$ and when $\Theta = \frac{\pi}{n}$, each of these minima equals $K_2 \cos \frac{\pi}{2n}$. The ratio of the minimum to the maximum value equals $\cos \frac{\pi}{2n}$. For a three-phase system this ratio is .866, and it diminishes very rapidly as n increases. It is evident that after Θ has reached the value $\frac{\pi}{n}$ the armature is, as far as concerns the resultant impressed E. M. F., in exactly the same position as at the start when $\Theta = 0$. We conclude, therefore, that E has $2n$ equal maxima and $2n$ equal minima during each revolution of the armature. In diagram Fig. 5 these fluctuations of E for a three-phase system are represented graphically.

CASE TWO.

The same relations hold good when n is even. The maxima take place when $\Theta = 0, \frac{2\pi}{n}, \frac{4\pi}{n}, \ldots\ldots$ The minima when $\Theta = \frac{\pi}{n}, \frac{3\pi}{n}, \frac{5\pi}{n}, \ldots\ldots$ and the ratio of any minimum to any maximum is $\cos \frac{\pi}{n}$. Since the magneto-motive force varies according to the same law as the resultant impressed E. M. F., it follows that the strength of the rotary magnetic field fluctuates periodically, having $2n$ equal maxima and $2n$ equal minima during each revolution, and the ratio of any minimum to any maximum equals $\cos \frac{\pi}{2n}$. That is, when n is odd; but when n is even then there are only n maxima and n minima, and the ratio of any minimum equals $\cos \frac{\pi}{n}$.

A polyphasal generator of this kind would produce a rotary magnetic field of constant strength only when $n = \infty$. For a three-phase system the maximum variation would be nearly 14 per cent. of the maximum value. This agrees perfectly with Mr. Dobrowolsky's calculations, but I fail to see how these calculations could justify any one to assume that they hold good for all types of polyphasal generators.* The generator which we have considered could be actually constructed, but its output would be so small in proportion to its size that we may dismiss it at once as an impracticable machine. We can make it practicable by substituting for the non-magnetizable ring, which carries the armature coils, a laminated iron ring, and for the uniform magnetic field the magnetic field of a well made field magnet, with

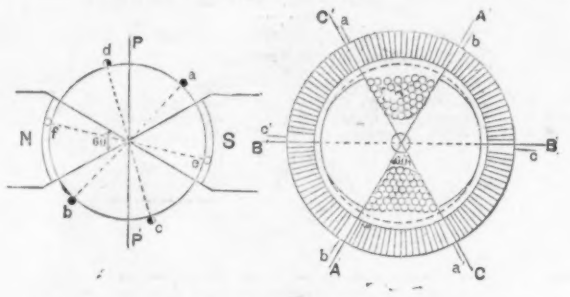


Figs. 6, 7 and 8.—Polyphasal Generators.

its pole pieces placed with respect to the armature coils in any one of the various ways sanctioned by practical experience.

But in a generator of this kind the resultant impressed E. M. F. will no longer vary according to the law which I have pointed out a little while ago. To be sure, we shall still have the same number of maxima and minima, as may be inferred readily from our knowledge of the shape of the E. M. F. curve of a continuous current dynamo. We all know that this curve is not in general a straight line, but a wave line having as many maxima and as many minima as there are sections on the commutator. But the ratio of the maxima to the minima is no longer an *a priori* calculable quantity. If we knew the mathematical relation between the intensity of the field at any point of the armature surface and the co-ordinates of this point with respect to the neutral plane then we could calculate that ratio, but the amount of experimental and practical work involved in this problem would be very great. A much easier and practically much more important problem is to determine the conditions which must be fulfilled in the construction of a polyphasal generator, in order that it may be capable of producing a rotary magnetic field of constant intensity in the simplest possible way, that is without the application of brushes and commutators. Mr. v. Dolivo-Dobrowolsky seems to think that a three-phasal generator is incapable of doing that, for he distinctly says that such a generator necessarily produces a rotary magnetic field whose strength varies 14 per cent. He also states that (evidently to obviate these fluctuations) the Allgemeine Electricitaets Gesellschaft employ a method of transmitting currents of smaller differences of phase than one-third of the period through three wires. In this point they claim to be ahead of Tesla, Bradley, Haselwander and Wenstrom. In fact, if one is not exceedingly careful in the perusal of Dobrowolsky's discussions of this subject he will be led to believe that the rotary field in some of Tesla's motors varied as much as 40 per cent., and certainly not less than 14 per cent. I do not think that Mr. Dobrowolsky wishes to be understood as holding that opinion; for neither he nor anybody else excepting Tesla himself can know what these variations were. The number of phases employed tells us nothing definite about the range of these variations.

A polyphasal dynamo which is capable of producing a rotary magnetic field of constant intensity must be constructed in such a way that its resultant magneto-motive force must remain constant as long as the speed and the magnetic field of the field magnets remain constant. As long as the variable electromotive force developed in each coil follows the law of a simple harmonic that result can never be accomplished by a finite number of phases, but it may, perhaps, be accomplished by producing in each of the generator coils a variable electromotive force which varies according to some definite complex harmonic law. In a well made commercial machine the electromotive forces developed in the various turns of the armature always vary according to some such law. The form of this complex harmonic law depends on the form of the magnetic field of the field magnets, and also on the distribution of the coils over the armature. The problem that remains to be investigated consists, therefore, of three parts: 1st. What must be the particular form of the complex harmonic E. M. F. developed in each coil of a polyphasal generator, in order that both the



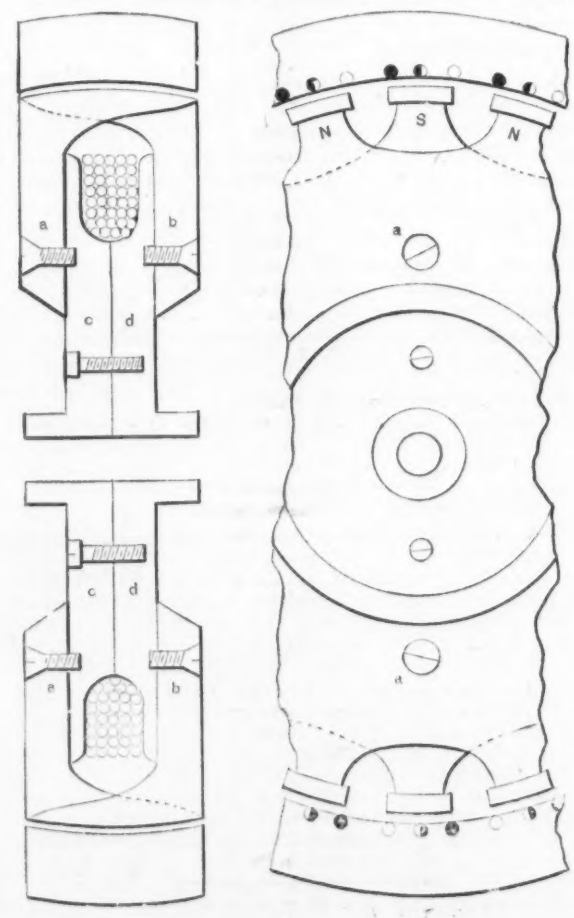
Figs. 9 and 10.—Polyphasal Generators.

condition of continuity be fulfilled, and also that the resultant impressed E. M. F. be continually constant? 2d. What form of the magnetic field of the field magnets will be capable of producing such an E. M F.? 3d. Can a continually constant resultant E. M. F. produce a rotary field of constant strength?

1. The first part of this problem is purely mathematical. In a paper read before the New York Mathematical Society I indicated a method of discussing this part in a general way, and worked out completely two particular cases, namely, the cases of a three and four phasal system. The paper is given in the appendix.

2. For a three-phasal system the form of the complex harmonic E. M. F. given in Fig. 7 will satisfy all the conditions. The form A, B, C, E, F, given in Fig. 8, is only a particular case and ought to be aimed at in the construction of the machine.

When there are only three turns within a space through which the armature moves with respect to the field during the time that corresponds to a complete period as in the case of the Lauffen generator (see Figs. 11 and 12), then the field of the field magnets must be constant in intensity during an angle which corresponds to one-sixth of the period. I have indicated that in the diagram Fig. 9. In the case of bipolar three-phasal generators, as indicated in the diagram Fig. 10, where we have six coils, the diametrically opposite pairs being connected in series; the pole faces must have an angular width of 120 degrees and the field must be constant in intensity within the region



Figs. 11 and 12.—Polyphasal Generators.

bounded at any moment by the armature and the pole faces. This is a practical problem offering no serious difficulties judging from the experimental results obtained by S. Thompson, Isenbeck, Mordey, and others, and also from the experimental results obtained lately by a graduate of our school, Mr. Freedman, John Tyndall Fellow of Columbia College.

The curve of impressed E. M. F. which must be produced in the case of a four-phasal generator is given in Fig. 13, and needs no further commentary. Larger numbers of phases offer no special advantages, whereas the disadvantages arising from employing a large number of phases are self-evident.

3. When a coil in which a simple harmonic E. M. F. is developed is closed by a resistance, whether self-inductive or non-self-inductive, the current which is set up in the circuit closed will be a simple harmonic, having therefore all the characteristics of the impressed E. M. F. This, however, is not necessarily the case when the impressed E. M. F. is a complex harmonic. A complex harmonic E. M. F. is composed of a large number of simple harmonic E. M. Fs. of different frequencies, all the higher frequencies being multiplies of the fundamental frequency. When, therefore, a coil in which a complex E. M. F. is generated is closed by a conductor, and the current is started, the current will be also a complex harmonic, each simple harmonic component of the complex harmonic E. M. F. producing its own simple harmonic current which is a component of the resultant complex harmonic current. But since the component simple harmonic E. M. Fs. have each a different frequency, it follows that they will have a different impedance and the shifting of phase will be also different for each component current, currents of higher frequency having a larger shifting in phase and also the ratio of the amplitude of any one of the component currents to the amplitude of any other component of lower frequency being smaller than the ratio of the amplitudes of the corresponding component E. M. Fs. In this respect the propagation of the complex harmonic current wave resembles very much the propagation of a complex harmonic sound wave or a complex harmonic light wave through an absorptive medium like air. The component simple harmonic

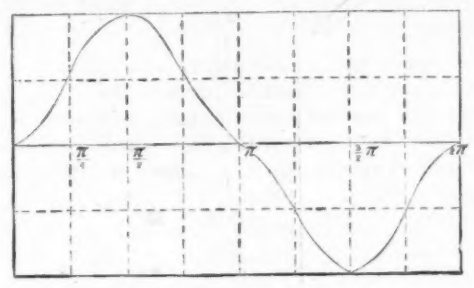


Fig. 13.—Polyphasal Generators.

waves of light and sound will in general suffer the less through the transmission the longer their wave length, just as the sound and light waves, after such a transmission, lose a great many characteristics of the original vibration which produced them, so an electric wave in its transmission through a conductor possessing ohmic resistance and electro-magnetic, not to speak of the electro-static, inductance will lose a great many characteristics of the impressed E. M. F.

To put this into simple symbolic language of mathematics,

Let L be the coefficient of self-induction of the circuit,

" R be the total resistance,

" $K \sum_1^\infty{}_m a_m \sin m\,p\,t$ be the complex harmonic impressed E. M. F., where $p = 2\pi \times$ fundamental frequency.

Let x be the value of the current at any moment t. We shall have, then $L \frac{dx}{dt} + R\,x = K \sum_1^\infty{}_m a_m \sin m\,p\,t$.

The solution of this differential equation gives

$$x = K \sum_1^\infty{}_m \frac{a_m}{\sqrt{R^2 + m^2 p^2 L^2}} \sin (m\,p\,t - \varphi_m)$$

$$\text{where } \tan \alpha_m = \frac{m\,p\,L}{R}.$$

The current x is a complex harmonic, its component simple harmonic currents being

$$x = x + x_2 + \ldots\ldots + x_m + \ldots\ldots \textit{ ad infin.}$$

$$\text{The current } x_\alpha = \frac{K\,a_\alpha}{\sqrt{R^2 + \alpha^2 p^2 L^2}} \sin (\alpha\,p\,t - \varphi_\alpha)$$

$$\tan \varphi_\alpha = \frac{\alpha\,p\,L}{R}.$$

Let E be the impressed E. M. F., then

$$E = e_1 + e_2 + e_3 + \ldots\ldots + e_m + \ldots\ldots \textit{ ad infin.}$$

The component simple harmonic E. M. F. e_α is given by

$$e_\alpha = a_\alpha \sin \alpha\,p\,t.$$

These relations give an exact quantitative expression to the preceding physical description.

These considerations made me hesitate at first in taking as granted that a polyphasal generator producing complex E. M. Fs., such as I deduced mathematically in the course of my paper, would be capable of producing a rotary magnetic field of constant intensity. But I was glad to find out that my hesitation was groundless, at any rate in certain particular simple cases.

Consider the three-phasal generator whose diagram is given in Fig. 10. Take now another *well-laminated* armature wound in a similar way as the armature of the generator. Connect the three pairs of coils of the generator to the three sets of coils in armature 2. We shall have three separate circuits, the ohmic resistance and the self and mutual inductance in each circuit being the same.

* M. v. Dolivo-Dobrowolsky: Der Drehstrom und seine Entwickelung; Officiele Austellungs Zeitung, Electricitaet, Heft 12.

Denote by $E_1 E_2 E_3$ the three complex harmonic E. M. Fs. in the three circuits. Let x, y, z be the currents at any moment. Then we shall have

$$L\frac{dx}{dt} + M\frac{dy}{dt} + M\frac{dz}{dt} + Rx = E_1$$

$$L\frac{dy}{dt} + M\frac{dx}{dt} + M\frac{dz}{dt} + Ry = E_2$$

$$L\frac{dz}{dt} + M\frac{dx}{dt} + M\frac{dy}{dt} + Rz = E_3$$

But since $E_1 + E_2 + E_3 = 0$ for all values of t it follows that $L\frac{d}{dt}(x+y+z) + 2M\frac{d}{dt}(x+y+z) + R(x+y+z) = 0$ for all values of t. This can be true only if $x+y+z=0$ for all values of t. That is to say, the currents fulfill the condition of continuity. We can therefore employ the method of polyphasal connection. Substitute now in the first of the three differential equations $z = -(x+y)$ and we obtain $(L-M)\frac{dx}{dt} + Rx =$

$$E_1 = K\sum_1^\infty{}_m a_m \sin m p t.$$

The solution of this equation gives

$$x = K\sum_1^\infty{}_m \frac{a_m}{\sqrt{R^2 + m^2 p^2 (L-M)^2}} \sin(m p t - \varphi_m).$$

Similarly

$$y = K\sum_1^\infty{}_m \frac{a_m}{\sqrt{R^2 + m^2 p^2 (L-M)^2}} \sin\left\{m\left(pt + \frac{2\pi}{3}\right) - \varphi_m\right\}.$$

$$z = K\sum_1^\infty{}_m \frac{a_m}{\sqrt{R^2 + m^2 p^2 (L-M)^2}} \sin\left\{m\left(pt + \frac{4\pi}{3}\right) \varphi_m\right\}.$$

In the case under consideration both L and M are pretty small when the metallic parts of the magnetic circuits are near the saturation point, so that $L-M$ is small, and $m^2 p^2 (L-M)^2$ will be very small in comparison to R^2 even for large values of m, unless the frequency is very high. Also since

$$\tan = \varphi_m \frac{m p (L-M)}{R}$$

φ_m is exceedingly small unless p is very large, we shall have for moderate frequency generators

$$x = \frac{K}{R}\sum_1^\infty{}_m a_m \sin m p t.$$

and similarly for y and z. The same method of reasoning may be easily applied to any number of phases. The mathematical operations will be considerably larger, but still the same results will be deduced without much difficulty.

That is to say, the curves for the currents are the same complex harmonics as those of the impressed E. M. F. The currents, therefore, produce a rotary magnetic field of constant intensity. This is evidently true even if these currents produce a saturation in the iron part of the magnetic circuits.

The resemblance between a polyphasal generator and a continuous current dynamo, which these relations bring into view, is exceedingly striking and instructive.

The advantages gained from a polyphasal generator capable of producing a rotary magnetic field of constant intensity would be very much diminished indeed if it should turn out that it is impossible to devise a simple and efficient method of transformation,* by means of which the polyphasal system of currents producing a rotary field of constant intensity (a constant rotary field system) can be transformed any number of times without losing its distinguishing characteristic. I intended to discuss this problem also this evening, but having been disappointed by the mechanician, who is constructing several pieces of apparatus illustrating this problem, I decided to postpone this discussion to some other time.

To sum up:

1. The consideration of simple harmonic impressed E. M. forces does not tell the whole story of the polyphasal generators.

2. The law of the variation of the strength of the rotary magnetic field which a polyphasal generator can produce is not as simple as Mr. v. D. Dobrowolsky thinks.

3. Polyphasal coupled transformers must be worked at low magnetizations and low frequencies, otherwise they will not satisfy the condition of continuity. It follows, therefore, that they will probably be very large for the output which they can give.

4. It is very probable that nearly constant rotary magnetic fields can be produced in practice by a small number of phases (perhaps not more than three phases) by properly shaping the curve of the impressed E. M. F.

A Change of Publication Office.

We are pleased to welcome our active popular contemporary, *Electricity*, to its new metropolitan home. Although the original publication office was in Chicago, much of the work was necessarily done in the East, and the change is probably a wise one that will result in increased prosperity. New York is a much better distributing centre for a popular journal than any other city in the country, and there has long been a tendency for periodicals to gravitate toward it, wherever they might originally start. The last number of *Electricity* was published here, and henceforward the Windy City will know its proof readers no more, though is likely to retain a very active acquaintance with their finished products.

*Not only transformation of the power supplied by the generator into electrical power of higher or lower potential, but also transformation of this power into mechanical power. This, of course, leads now into the discussion of the rotary fields produced under conditions which are met with in practice.

Financial Intelligence.

THE ELECTRICAL STOCK MARKET.

The Closing Quotations of electric stocks on Saturday, Dec. 19, 1891, in New York and Boston were:

Name of Stock.	Par.	Capitalization.	Bid.	Ask'd.
Western Union Telegraph Co	100	86,200,000	....	....
American Telegraph & Cable	100	14,000,000	....	....
Central and South American	100	5,000,000	....	....
Mexican	100	2,000,000	....	....
Commercial Cable Co	100	7,716,000	....	....
Postal Telegraph Cable	100	5,000,000	....	....
Edison General Electric	100	15,000,000	....	95½
Thomson-Houston Electric Co.	25	6,000,000	49⅛	49½
" " preferred.	25	4,000,000	27	..
" International Electric Co	100	1,000,000	175	200
Thomson Electric Welding Co.	100	1,000,000	40	60
" European Electric Welding Co	100	1,500,000	15	20
Westinghouse Electric Co., assented	50	7,000,000	12½	13
Fort Wayne Electric Co	25	4,000,000	12	12½

Dec. 16.

Chicago Quotations.—Col. S. G. Lynch, broker, 153 Monroe street, Chicago, furnishes quotations on electrical stocks as follows:

TELEPHONE STOCKS.

Chicago	$224	$226	Cumberland	$60	$62
Central Union	52	53	Wisconsin	118	120
Michigan	81	83	Bell of Missouri	175	180
Great Southern	30	32	Missouri & Kansas	54	56
Colorado	34	36	Iowa Union	20	22
Rocky Mountain Bell.	40	43			

ELECTRICAL STOCKS.

Chicago Arc Light and Power	$83	$85	Chicago Edison Co	$139	$140

NEW INCORPORATIONS.

The Newark Chandelier Works, of Newark, N. J., capital stock $25,000, has been formed to manufacture gas and electric light fixtures of every kind. L. F. Mergott and A. T. Oppel, all of Newark, are the incorporators.

The Newville Electric Light, Heat and Power Company, of Newville, Pa., with a capital stock of $5,000, has been organized to furnish light, heat and power. The incorporators are W. G. Stewart, Stacy G. Glauser and Jos. A. Woodburn.

The Belleville Electric Light Company, of Belleville, N J., with a capital stock of $100,000, has been incorporated to construct and operate works for supplying and distributing electricity. A. F. Crawford, E. S. Frazer, and H. V. Cole are the incorporators.

The Middletown, Highspore and Steelton Street Railway Company, of Middletown, Pa., capital stock $100,000, has been formed to operate an electric street railway from Middletown to Steelton. The incorporators are G. W. Cumbler, Jno. W. Rife and Sol. Zimmerman.

The Massachusetts Wire Company, of Malden, Mass., capital stock $25,000, has been organized to draw and cover any and all kinds of magnet or other wires, etc., etc. John S. Bartlett, of Lynn; Frank Dewing, of Boston, and Jesse Scribner, of Waltham, Mass., are the incorporators.

The West Jamaica Electric Light Company, of Richmond Hill, N. Y., capital stock $2,500, has been incorporated, to manufacture and use electricity for light, heat and power, etc. George Lester, William Kessler and O. W. Graves, all of Richmond Hill, are interested in this new concern.

The State Electric Light, Heat and Power Company, of Jersey City, N. J., capital stock $100,000, has been organized to generate and supply electricity. H. V. Cole, of Belleville, N. J.; Edw. S. Frazer, of Mt. Vernon, N. Y., and A. F. Crawford, of Haverstraw, N. Y., are the incorporators.

The Electric Reduction Company, of Albuquerque, N. M., capital stock $20,000, has been incorporated for the purpose of reducing gold, silver and other ores, etc. A. M. Codington, J. C. Baldridge, H. H. Ferguson, Frederick M. Kent, E. S. Stover, Calvin Whiting, Chas. E. Winslow, G. W. Harrison and M. S. Otero are the promoters.

The New York Electric Railway Company, of Jersey City, N. J., with a capital stock of $25,000, has been organized to build and construct railways of all kinds, including surface, elevated and underground railways, etc. T. W. Elcott, L. Alder, Philip Payne and Benjamin Tuska, all of New York City, and Jno. W. Hyatt, of Newark, N. J., are the promoters.

The National Electro-Therapeutic Alarm Company (incorporated in W. Va.), of Washington, D. C., capital stock $100,000, manufacturing and buying electro alarm and electro-therapeutic apparatus, or any other system of electro alarms, and controlling and owning patents relating thereto. Leonides G. Wooly, of Grand Rapids, Mich.; Frank K. Raymond, Thos. B. Coulter, of Washington, D. C., are the incorporators.

A. C. Robertson & Co. is the name of a new electrical company which has been recently incorporated in New Jersey. The company is composed of Albert C Robertson, of Wilkesbarre, Pa.; Alex. G. Carpenter and Emery C. Carpenter, of Princeton, N. J., and will be ready for business within a very short time. It will manufacture electrical specialties and keep in stock a line of general electrical supplies, and will also construct electric railways, lighting plants, etc. The business of the company will be conducted at Princeton, N. J., and Wilkesbarre, Pa.

AFFAIRS OF THE COMPANIES.

Delta, Pa.—The capital stock of the Delta Electric Light Company has been increased from $2,000 to

The International Bell Telephone Company has declared a dividend of four per cent, payable Jan. 4, 1892.

The Royal Electric Company, of Montreal, Can., has declared a quarterly dividend of two per cent. on the paid-up capital stock of the company.

The Thomson-Houston Electric Company has declared a semi-annual dividend of 3½ per cent. on the preferred stock, payable Jan. 1, to stock of record Dec. 22.

The Bell Telephone Company is under contract to pay the city of Toronto five per cent. of its quarterly receipts. The company has recently turned over to the city $1,172, for the three months ending Dec. 1.

The Directors of the Thomson-Houston at their recent meeting declared a semi-annual dividend of 3½ per cent. on their preferred stock, and made the same payable Jan. 1 to stockholders of record Dec. 22.

The Central & South American Cable and Telegraph Company has increased its capital stock from $6,000,000 to $6,500,000. The increase, it is stated, is for the purchase of the Transandine Telegraph Company lines.

Beatrice, Neb.—Amended articles of incorporation of the Beatrice Light and Power Company have been filed; the capital stock is $250,000. Incorporators: Ed. P. Maxwell, Fred. J. Maxwell, Wm. Pickrell, E. A. Watrous and E. J. Smith.

The Capital Stock of the Baltimore, South Baltimore & Curtis Bay Railway has been increased to $100,000, and a complete electrical equipment for the same has been ordered. It is expected that the road will be running about May 1, 1892.

Erie, Pa.—The annual meeting of the stockholders of the Erie Electric Motor Company will be held at the office of the company Erie on Dec. 31, for the purpose of deciding whether or not the debtedness of said company shall be increased.

California, Pa.—At a recent meeting of the stockholders of the Electric Light Company of California and Coal Centre, Isaac Leadbetter, of Coal Centre, was elected temporary president of the company; Dr. J. A. Letherman, secretary; W. H. Bins, treasurer, and W. H. Gregg, vice-president.

Winchendon, Mass.—At the annual meeting of the Winchendon Electric Light and Power Company, the following officers were elected: President, M. E. Converse; treasurer, S. A. Greenwood; secretary, A. I. Goodspeed; board of directors, W. A. Carey, C. B. Davis, M. E. Converse, F. W. Russell, S. A. Greenwood, J. N. Richardson, G. N. Goodspeed.

Special Correspondence.

NEW YORK NOTES.

OFFICE OF THE ELECTRICAL WORLD,
167-177 TIMES BUILDING, NEW YORK, Dec. 14, 1891.

Prof. Elihu Thomson was in the city last week. He came on to preside at the meeting of the American Institute of Electrical Engineers, at which Mr. M. I. Pupin read his paper on "Polyphasal Generators."

Union of the Messenger Companies.—It is now definitely announced that the American District Telegraph Company and the Mutual Telegraph and Messenger companies will form a consolidation at the beginning of the year.

"Search Lamp for Chili" was the order given at the office of the "Ward" Arc Lamp, technically known as the Electric Construction & Supply Company, 18 Cortlandt street. The fame of the "Ward" lamp has extended beyond the broad acres of the States.

Harold P. Brown, of electrical execution fame, was in New York last week. Mr. Brown is now at work on a new street railway motor which he believes to be a winner. It will soon be ready for the market. Whatever Mr. Brown does is of interest to the electrical profession.

H. W. Seely, of Dyer & Seely, Edison's patent attorneys, returned Friday from Kalamazoo, Mich., where he has been investigating the electric railway invention of Geo. F. Green, to whom was recently issued the very broad patent for electric railways which has created such a stir in electrical circles.

The Great Operating Room of the Western Union Telegraph Company, re-arranged and remodeled since the recent fire, will be opened Christmas Day. This is now one of the finest operating rooms in the world. Its different features were fully described in a recent issue of THE ELECTRICAL WORLD on page 370.

Mr. William McVay will deliver a lecture before the Brooklyn Institute department of physics on Wednesday evening, Dec. 23, on "Induction Electric Machines and Electrostatic Motors," with experimental demonstrations. The lecturer will illustrate and explain numerous motors of his own invention and construction.

Henry Stevenson, so long in charge of the underground work of the Edison Illuminating Company, of New York, has lately assumed charge of the construction department of that company. Though a very young man, Mr. Stevenson has made a good record in having equipped the largest and most complete underground system of electric conductors ever attempted. L. H. H.

ALBANY, N. Y., Dec. 19, 1891.

Mr. William H. Cull, the electrician of the Hudson River Telephone Company, is in Richmond, Va., examining the Law system of telephoning.

Officers Re-elected.—At the annual meeting of the Albany Electric Illuminating Company held Monday the officers of the company were re-elected.

New Cars for Boston.—Three handsome motor cars were shipped Monday from the Jones Car Works at West Troy, to the West End Street Railway Company of Boston.

An Opportunity for Electric Heaters.—The Albany Railway is experimenting with a new hot-water heater, which is stationed on the platform of the car. The company will adopt them for its motor cars if they prove satisfactory. This road was the first to use stoves for heating its horse cars.

Electric Cars at Greenbush, N. Y.—A village ordinance was unanimously adopted at a meeting of the trustees of the village of Greenbush, Tuesday last, granting the Albany Railway the privilege of running cars through Broadway from the Greenbush bridge on the south to the Northern boundary of the village. R. V. T.

PHILADELPHIA NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
927 CHESTNUT STREET, PHILADELPHIA, Dec. 19, 1891.

Mr. W. Markland, superintendent of the Pennsylvania system of electric light service at Altoona, is now visiting this city.

The Peoples' Passenger Railway Company, it is reported, although for some time contemplated, is at last Traction property.

Mr. James McMillon, manager of the Cambria Iron Company, of Johnstown, Pa., is at present visiting in Philadelphia and is stopping at the Continental Hotel.

The Quaker City Railroad Company, of Harrisburg, Pa., has been chartered, with a capital of $150,000, to construct a 12-mile line in that city. The president of the company is Thomas Briggs, of Newtown.

The Middletown, Highspire and Steelton Street Railway Company has been granted a charter. The length of the road is to be seven miles; route from the borough of Middletown to Swatron to Steeltown borough. Capital stock, $100,000.

Mr. Thomas T. Tasker, the eminent iron founder of this city, is reported to be in a prostrate condition, owing to an acute

attack of bronchitis. Mr. Tasker was the founder of the prosperous firm of Morris Tasker & Co., well known in electrical circles.

The Philadelphia Traction Company is thought to have leased the Thirteenth and Fifteenth street line. By this deal the proposed "Bus line" on Broad street will probably be abandoned as the Traction can, by a system of transfers with its new acquisition, effect the required results.

The Spellier Electric Time Company at a recent annual meeting elected the following officers for the ensuing year: A. B. Cutter, president and general manager; E. M. Dobelhower, secretary and treasurer. The report of the treasurer showed the affairs of the company to be in a good financial condition, and the prospects for the enlargement of its business could not be brighter.

The Trades League of Philadelphia is agitating the movement of bridging the Delaware River, and thus connecting the city with Camden. The idea is to have a structure similar to that magnificent accomplishment in bridge construction known to the world as the Brooklyn Bridge, to differ only in the mode of car propulsion. Philadelphia proposes "to go" New York "one better" by adopting electricity in place of the cable. It will be apparent to all that the many benefits accruing through the accomplishment of such a grand undertaking would be greatly to the advantage of both cities.

Director Windrim has received from Chief Walker of the Electrical Bureau a report on the bids for the city electric lighting for 1892. The aggregate amount of the bids is $268,800, or $2,800 more than is in the appropriation bill for lighting, and it will be necessary for the Council to increase the appropriation to the amount of the bids. The bids are from the Electric Illuminating, formerly the Electric Power Company, and the Brush company the Powellton, Germantown and Wissahickan, the Diamond, the Southern Manufacturers and the United States. The average price per light will be about 42 3-5 cents per night and $156 a year.

The Bell Telephone Company sent a reply to the Trades League, which was submitted at their meeting held recently at the Manufacturers' Club. The lower rates and improved service asked for were receiving careful attention. The hindrances confronting the company in this city were: Difficulty in securing the necessary franchise and delay in reconstructing disabled lines; the interference of the electric lights and power plants have caused defective service, and the company, seeing that the overhead system cannot give satisfaction, are availing themselves of the underground system, which entails a cost of $500,000. The outlay and cost of service make it difficult to settle rates, but they will be fully considered when the company can fairly do so.

Immediate Rapid Transit.—The citizens are becoming anxious, and in fact demand better rapid transit facilities, and the mass of the people favor electric transit. Referring to the matter a Philadelphia paper has the following: "Investigation shows that there is no validity in the objection that the trolley wires and electric cars are more dangerous in their operation than other means of surface transit. President Whitney, of the Boston West End Railways, which are a combination of electric and horse lines, says the electric lines are the safest. The number of accidents on the West End system during the last two years per passenger carried has been less on the electric than on the horse cars. A still better evidence as to the question of safety is afforded by the ratings of the casualty companies, whose insurances are lowest on the electric systems, next on the cable cars, and heaviest on the horse cars. There is no answer to this form of testimony. Money talks. Improved cars, quicker time, better roadbeds, greater cleanliness, better lighting, better heating, cheaper construction, and, as a consequence, cheaper fares, are advantages immediately available upon the introduction of the electric system. Why should the people of Philadelphia be asked to wait for rapid transit until costly overhead or underground railways shall have been built and made available for use, perhaps by the end of the century?" W. R. W.

NEW ENGLAND NOTES.

Branch Office of The Electrical World,
Room 28, Hathaway Building, 620 Atlantic Ave.,
Boston, Mass., Dec. 19, 1891.

Two Spaniards from South America have recently entered the Thomson-Houston Electrical Works, at Lynn, for the purpose of taking an expert course in electrical engineering and construction. C. A. B.

WESTERN NOTES.

Branch Office of The Electrical World,
465 The Rookery, Chicago, Dec. 19, 1891.

Taylor, Tex.—It is stated that the new electric light plant will be in operation about Jan. 1.

Dubuque, Ia.—It is stated that the City Council contemplates operating its own electric light plant.

Clinton, Ia.—The Clinton Gas Light and Coke Company has purchased the electric lighting plant of the State Electric Company.

Farmington, Ill.—The City Council has contracted for an incandescent plant of 55 lights of 32-c. p. each. The plant will be in operation by the first of the year.

Mr. J. P. Barrett will read a paper before the Chicago Electric Club on Monday evening, Jan. 4, on the subject of "Electrical Exhibits During the World's Columbian Exposition."

Lansing, Mich.—The Lansing Street Railway Company has been transferred to the Continental Trust Company, and the capital stock has been increased from $50,000 to $100,000 for the purpose of extending and improving the system of the lines.

Rockford, Ill.—The Rockford Electric Manufacturing Company has been meeting with considerable success in its business, and it has grown to such proportions that an enlargement of its plant has become necessary. Mr. W. B. Roberts, formerly connected with the Gilliland Manufacturing Company and late manager of the Wisconsin Telephone Company's lines, it is stated, will shortly become connected with the company, and will assist in its management.

Hastings, Neb.—Mortgages aggregating about $4,900, and a judgment of $3,000 were recently filed for record by the creditors of the Hastings Electric Light Company. These are subject to a prior mortgage of $11,000. It is also stated that there is a chattel mortgage of $1,250 on some of the machinery, and a mechanic's lien for about $1,500 on the property, making a total indebtedness of about $21,000. It is thought the affairs of the company will be adjusted, and the plant continue in operation. F. de L.

Kansas City, Mo., Dec. 18, 1891.

Mr. C. A. Ross, of the Thomson-Houston Company, has secured the contract for a 650 incandescent light plant at Enterprise, Kan.

Mr. A. F. George, a local inventor, has just completed a model of a spring motor, which he claims will completely revolutionize rapid transit and put electricity among the back numbers. It is attracting considerable attention among moneyed men, and a company is being organized.

The Southwestern Electrical Supply Company, with headquarters in the New York Life building, has made an assignment for the benefit of its creditors. The company has been in business here a number of years and was regarded as fairly prosperous. Slow collections are said to be the cause.

St. Paul, Minn., Dec. 18, 1891.

Mr. J. T. Hamby, of the Beacon Vacuum Pump Company, of Boston, is a visitor in St. Paul this week.

Farmington, Me.—The Farmington Electric Light Company has sold its plant to the Edison and N. E. wiring companies.

Mr. E. T. Gilliland, of New York, inspected the beautiful and the picturesque in St. Paul and Minneapolis on Tuesday, and incidentally talked quietly about business in general.

General Tourist Morgan, of the Charles Munson Belting Company, Chicago, secured some handsome orders for belting in St. Paul and vicinity this week. Last week he obtained the order for belting the steam and electric plant in the Leiter building, Chicago, including two 48-inch, two 12-inch, seven 10-inch and one 6-inch leather belt.

Mr. J. M. Denniston, formerly in charge of the isolated sales department of the Westinghouse Electric Company for the territory of Chicago and Milwaukee, is now the traveling auditor of the Northwest Thomson-Houston Electric Company, Silbey street, St. Paul, and is kept constantly on the move. An active business man and successful in whatever he undertakes, Mr. Denniston is a good addition to the energetic business corps that are pushing the sale of Thomson-Houston apparatus in every corner of the Northwest.

CANADIAN NOTES.

Ottawa, Dec. 19, 1891.

Winnipeg.—Nothing has yet been definitely decided upon with regard to the electric street railway it was proposed to construct through that city.

Toronto.—The Toronto Incandescent Electric Light Company, Limited, announces that a cash discount of 20 per cent. will be allowed on all accounts rendered for incandescent electric lights after Jan. 1 next.

Almonte, Ont.—Mr. John B. Wylie has asked permission to erect electric light poles within the corporation limits. The light to be produced is to be the incandescent system—to be used for the lighting of stores, private dwellings, shops, churches, etc.

Winnipeg.—The city of Winnipeg will receive tenders up to the 22d of December for electric street lighting; tenders to state a rate per light per night for each additional light over 100. Term of contract to be three years, the city, however, to have the right to take over the street plant only at a valuation at any time during the existence of the contract upon giving 12 months' notice and to terminate the contract.

Peterboro, Ont.—There are two parties applying for the franchise for an electric street railway, the Peterboro & Ashburnham Company, and another company called the Edison Syndicate, comprising prominent members of the Edison General Electric Company. The Town Council was unable to agree upon giving the franchise to either company, and the matter of which shall receive the franchise is to be decided by popular vote, to be taken on Dec. 23.

Hamilton, Ont.—There is every indication that the scheme to build an electric railway from here to Grimsby Park will be carried out. A meeting to discuss the plan was held last week. Mr. Myles explained his scheme. He said the road would cost from $107,000 to $125,000, and that the earnings would be $156 a day and the expenditure $100 a day. His plan to bring the power from Welland canal waste wiers had been abandoned and a power station would be located at the Winona station, to which point it was proposed to run a side track from the main line. A committee was appointed to meet Mr. Carpenter and discuss with him the terms upon which he would allow the trolley cars to run over his roads. If the projectors can come to terms with Mr. Carpenter the road will be built.

Vancouver, B. C., Dec. 16, 1891.

A Crompton dynamo has been installed on the Pitt Meadows dredge, just built here.

An Edison three-wire plant has been inaugurated at Kamloops. The machines are well loaded to start with.

Electric Railway Extension.—The Mount Pleasant & Fairview extension of the Electric Railroad has just been opened. This adds about 3 miles of track.

Phonograph Agency.—The agent for the North American Phonograph Company has made this city his headquarters for Alaska, Alberta and British Columbia, with offices in the Edison Building.

The electric car service lately opened between this city and New Westminster has proved such a success that the Canadian Pacific Railway Company has been compelled to discontinue trains to that city.

The Vancouver Electric Railroad and Lighting Company has decided to double its paid up capital stock. This company has given notice of its intention to provide a system of heating for private houses.

New Mica Mine.—A deposit of what has turned out to be very fine mica has just been found not far from Kamloops. Judging by the samples, it is of a very superior quality. It has already been bonded to an Eastern electrical company.

Storage Batteries for Divers.—The divers in the employ of the city water-works department have added a very complete set of Carpenter storage batteries and lamps to their plant. They will now be able to work at night and during rough weather.

New Telegraph Line.—The directorate of the B. C. District Telegraph and Messenger Service Company, with headquarters in Vancouver, have made arrangements with Nanaimo and New Westminster and services will be established in these cities.

The Jeffrey Manufacturing Company, of Columbus, O., recently installed a complete electrical coal cutting plant in the coal mines at Comox. After a fair trial it has been decided to equip two of the other mines with the same type of plant. The generator, which is set on a mica and glass foundation, is driven by an Ide engine. Mr. Ossyer, the constructor, deserves much credit.

News of the Week.

THE ELECTRIC LIGHT.

Ludington, Tenn.—The proposition to bond the city for $5,000 for electric lights has been carried.

Grand Island, Neb.—Arrangements are being perfected for an incandescent electric lighting system.

Florence, Ala.—The Florence Gas, Electric Light and Power Company will add a new dynamo to its plant.

Clinton, Mich.—Floyd Starrett is negotiating with the citizens for the establishment of an electric light plant.

Plymouth, N. H.—It is expected that the new electric light plant will be completed by the first of January.

Cummingsville, O.—A stock company is being formed for the purpose of the erection of an electric light plant.

Mobile, Ala.—The City Council has advertised for bids for the erection of an electric light plant for the use of the city.

Tenafly, N. J.—A proposition has been made to the township committee in regard to the erection of an electric light plant.

Rock Island, Ill.—The Merchants' Company has recently put in place a 200-h. p. dynamo for the generation of electricity for power purposes.

Lenoir, N. C.—The Morganton Development Company has contracted to furnish the town with electric lights within 12 months from Jan. 1, 1892.

Quakertown, Pa.—The question of erecting an electric light plant and of bonding the borough in the sum of $22,000 for the same will be put to vote Dec. 29.

Mitchell, S. Dak.—The Thomson-Houston Electric Company has commenced work on its new central station, and expects to have its plant in operation soon.

Silver Springs, N. Y., has adopted the electric light, and the work of putting it in has been commenced. Incandescents will be used for street lighting instead of arcs.

Thompsonville, Conn.—The electric light company will soon have its plant in operation, the new dynamo having arrived, and a 100-h. p. engine which will be soon placed in position.

The National Electric Light Association will hold its next meeting on Feb. 23, 24 and 25, at Buffalo, N. Y. The date was fixed at a recent meeting of the executive committee.

Annapolis, Md.—The City Council will petition the Legislature to empower it to issue bonds amounting to $90,000, to enable it to build an electric light plant, and make other improvements.

To Have Electric Light.—The following towns and cities of the United States are agitating the question of electric lighting: Carbon, Wyo.; Wilmington, O.: DeGraf, O.; Eldora, Ia.; Stanton, Mich.; Shawneetown and Greenfield, Ill.

Bristol, R. I.—The Bristol Electric Light Company has recently received and is putting in place a new incandescent dynamo of 1,300-c. p. capacity, and an arc light dynamo of 45-light capacity, which materially increases the capacity of its plant.

The Rutland Electric Light Company has started another 50-light arc dynamo and two incandescents; also another 75-h. p. generator. This gives a capacity of 300 arcs and 1,200 incandescents and 100 h. p. for motors, requiring three engines and making this plant the largest in the State.

Westminster, B. C.—The City Council has decided to furnish light to all comers, and the demand has been so great that it intends to remodel the station. A new engine has been ordered besides two incandescent and one arc machine, from the Royal Electrical Company of Montreal. A 50 arc light Edison machine is to be placed in MacGilvany's steel pipe works. The electric car service is giving great satisfaction, and a fair business is being done.

A gigantic electric lighting plant, it is stated, is to be constructed in Chicago by the Edison Electric Lighting Company, which will be the largest in the world. The ground alone for the structure will cost from $300,000 to $500,000, and it is reported that the company has already taken steps for the erection of the plant, which will cost nearly $1,000,000 over and above the cost of the site for the same. The plant is to furnish Chicago with an electric light service that will leave in the shade all similar plants in any other part of the world, and one that in its equipment will be complete in every detail. It is thought that the location has already been decided upon, although negotiations for the purchase of the land are still pending.

THE ELECTRIC RAILWAY.

Newark, O.—The question of granting a franchise to the Newark Street Railway Company to construct and maintain an electric railway on streets of the city is being seriously considered. There seems to be considerable opposition on the part of citizens.

Electric Cars in Chicago.—Chas. T. Yerkes states that he has made arrangements to purchase the right to operate street railways under the Siemens, Halske & Co.'s electric system. If it proves a success an experimental line will be built on Twelfth street.

Fresno, Cal.—The Fresno Electric Railway Company, with a capital stock of $1,000,000, has decided to change the street railway systems of the city to electric lines, and will build 40 miles of road to Hanford. It is stated it is the largest electric railway scheme yet undertaken.

Haverill, Mass.—The Lowell, Lawrence & Haverhill Street Railway Company was recently incorporated at Lowell, by Chas. W. Morse and others, for $600,000, for the purpose of building an electrical road from Haverhill through Lawrence, Methuen, Dracut, Andover and Tewksbury.

Los Angeles, Cal.—The Los Angeles Consolidated Electric Railway Company has recently been equipped by the Westinghouse Electric Company, and is running 30 cars, one-half of which have gearless motors, and the others the single reduction motors. The road is 32 miles in length, and 10 more miles are being constructed. The entire car equipment will consist of 70 cars.

Mt. Airy, O.—The citizens of Mt. Airy are discussing the building of an electric road to Cincinnati. The plant for operating it would doubtless be located in Cumminsville, and would not only be used for furnishing power to the road, but also to furnish electric lights to the people of the Twenty-fifth Ward, who have heretofore depended solely on gas for illuminating their dwellings.

Atlanta, Ga.—The Atlanta Consolidated Street Railway Company, in which Boston capital is largely interested, has recently voted to build a two-mile extension of its line. The earnings of the road have steadily grown since the new management assumed control, and at the present time are larger than ever before in the company's history. For October they amounted to $37,302, as against $35,136 last year, and for November they were even better than this.

An Electric Road on Martha's Vineyard.—One of the longest electric railways in the world, its proposed route being over a distance of nearly 25 miles, is to be built on the Island of Martha's Vineyard. It will be known as The Dukes County Street Railway. It is capitalized for $200,000. The officers of the company are as follows: Charles H. Emerson, South Framingham, president; Chas.

Strahan, Cottage City, secretary; George M. Clough, of Somerville, treasurer, and Everett Allen Davis, of Boston, attorney. The route will run from Cottage City, Tisbury and Chilmark to Gayhead.

Boston, Mass.—The net earnings of the West End railway in October are reported as $173,000, an increase, it is said, of $36,000 over 1890. The gross earnings from Oct. 1 to date have maintained the normal gain of about $1,000 per day. The company will discontinue the custom of the past season in issuing exhibits of operations monthly, and give them out quarterly. The company will put on some 175 additional electric cars between this date and Feb. 1, all equipped with noiseless motors, similar to that in use upon the double-deck car. This car is carrying a great many passengers, and at large profit. One-half of the passengers are shown by statistics to occupy the upper deck.

A big street railway deal was recently consummated at Pittsburgh, Pa., by which the stockholders of the Pittsburgh & Duquesne Traction lines, the First Cable and the other electric lines which run parallel to each other for five miles to the east end, at a recent meeting ratified an operating contract, and the Pittsburgh Company takes charge of the Duquesne lines, with a combination of receipts, under a lease for 99 years. The deal is an important one, as the owners of the Pittsburgh lines are largely Eastern capitalists, among whom are Messrs. Widener and Elkins, of Philadelphia, Daniel Lamont and William C. Whitney, Chris. McGhee being the chief stockholder in the Duquesne company. The Duquesne lines are extensive ones, including branches having about 31 miles of track. The Pittsburgh roads cost millions for construction. It is stated that by the result of the deal the syndicate becomes the controllers of the passenger carrying traffic of every large city in the union.

LEGAL NOTES.

The Cowles Electric Smelting and Aluminium Company, of Cleveland, O., has filed a bill in equity against the Pittsburgh Reduction Company asking for an injunction preventing the defendant company from using certain patents for smelting ores by electric currents, claiming priority for the invention and the patent.

In the United States Circuit Court, Philadelphia, recently, Judge Atchison presiding, a provisional injunction was granted to the Electric Gas Lighting Company against J. Y. Parke under Letters Patent No. 225,071, which cover the electric ratchet hand-lighting gas burners. This is a decision in line with the opinion rendered by Judge Colt in the District of Massachusetts in the case of the same company *vs.* Fuller, Holtzer & Co., and seems to confirm the exclusive rights of the Electric Gas Lighting Company in the case. It is stated that since the suit in Massachusetts there has been some disposition to contest the rights of the company elsewhere

Electric Riveting Patent Decision.—A decision has just been rendered by the Commissioner of Patents in the interference proceedings which have been pending for some years past between Mr. Elias E. Ries, of Baltimore, Md., and Prof. Elihu Thomson, in which the commissioner sustains on final appeal the original decisions of the Examiner of Interferences, awarding priority of invention to Mr. Elias E. Ries. The interferences were two in number, one covering the method and the other the apparatus for practicing this method. The former was between an application of Elias E. Ries filed as a division of a prior application dated Sept. 15, 1888, and patent No. 396,015 erroneously issued to Prof. Thomson on Jan. 8, 1889, upon an application filed by him on Oct. 12, 1888, while both applications were pending together before the same examiner. The second interference was between the patent of Elias E. Ries, No. 403,374, granted May 14, 1889, and an application of Prof. Thomson filed on June 14, 1889.

PERSONALS.

Mr. F. C. Hutchins, of Pittsburgh, has been appointed superintendent of the Vancouver (B. C.) Electric Railroad, Light and Power Company

Mr. Walter W. Nicholson, formerly of the Utica Telephone Exchange, has, been appointed general superintendent of the Central New York Telephone Company, with headquarters at Syracuse.

Mr. Geo. W. Wood, who has been a division superintendent of the Central New York Telephone Company, with an office in Little Falls, will succeed Mr. Nicholson as division superintendent for Oneida, Madison and Lewis counties.

Mr. F. E. Pritchard, formerly with the People's Electric Light and Power Company, Oswego, N. Y., will on Jan. 1, '92, become connected with the Brush Electric Light and Power Company, of Niagara Falls, N. Y., as consulting electrician.

Mr. F. L. Dame, Superintendent of the Vancouver (B. C.) Electric Railroad, Light and Power Company, has resigned and taken a position with the Thomson-Houston Electric Company as district engineer, with headquarters at Portland, Ore.

Mr. W. H. Girvan, general superintendent of the Central New York Telephone Company, with headquarters at Syracuse, has tendered his resignation, to take effect Dec. 31. He has taken a position with the Syracuse Electric Light and Power Company.

Mr. John Roy, of Truex & Vail, 136 Liberty street, New York, has gone to St. Paul, Minn., where he will install in the private house of Mr. Hill an isolated electrical lighting plant, of 600 accumulator cells, of the largest size. It is stated that the plant will be one of the finest isolated electric lighting plants for private purposes in the country.

C. H. Coster, the well known District Manager of the Edison General Electric Company, for the Rocky Mountain District, died suddenly at Schenectady on Monday morning. Mr. Coster has long been in feeble health. He was located in Denver in the hope that his condition would improve. He seemed on the mend, and lately came East to attend the conference of Edison managers. In Mr. Coster's death the Edison interests lose a valued manager, and the electrical industry an earnest worker and careful student.

MISCELLANEOUS NOTES.

Changes in the Boston Electric Club.—Secretary Ross, of the Boston Electric Club, has sent us the following denial of the reported disintegration of that organization: Since it has been announced in some of the electrical journals that "the New England Electric Club is to be formed to take the place of the Boston Electric Club," will you kindly state in your next issue, in justice to the Boston Electric Club, that such is not a fact. The Boston Electric Club is not dead, nor has it surrendered its charter. We have simply given up our permanent headquarters and disposed of our furniture and effects. Henceforth the club will be perpetuated in the form of monthly dinners, lectures, etc. Our constitution and by-laws have been revised, annual dues reduced to an almost nominal figure, and such other changes made as we think will result beneficially. On the first Monday evening in January (the 4th) we propose having our inaugural dinner.

Mr. Edward T. Cook, of the Edward T. Cook Electric Company, of St. Louis, Mo., has written us in regard to the purpose of the organization of the association known as the St. Louis Electric Exchange. As stated, the object of the association is as follows: "This association is organized for commercial and social purposes, and has for its special objects the advancement of the trade in all the latest discoveries of science appertaining to the practical introduction of the latest improvements in the electric art. To promote and combine the intelligence and influence of members for the protection of the trade against imposition, injustice or encroachments upon our common rights and interests; encouraging inventions and improvements appertaining to the electrical business, fostering an interchange of thought, and eliciting and communicating, for the benefit of each member, the best talent and the result of the experience and ability of all; to promote amicable relations with employés on the basis of mutual interest and equitable justice to both employer and employés; to encourage national and State legislation for the furtherance of the interests of electrical business; to secure for the members of the trade equitable treatment in their dealings with manufacturers and dealers in supplies; to regulate the system of apprenticeship and employment, so as to prevent as far as practicable the evils growing out of deficient training in the responsible duties, to create and maintain a standard code at as high a standard as the progress of practical science teaches. And we agree to carry forward with tireless zeal the great work to which the above language relates."

Industrial and Trade Notes.

The Cleverly Electric Works, of Chestnut street, Philadelphia, reports having all it can attend to in the line of special work.

Partrick & Carter, 125 S. Second street, Philadelphia, report business in all lines as steadily increasing and a big trade for 1892 is looked for.

Vallee Bros., of Philadelphia, report business in their different specialties as on the increase, not particularly in any special line but in the supply business generally.

The Moore and White Company, of Philadelphia, has recently shipped to Robt. Wetherill & Co., of Chester, Pa., two 500-h. p. clutches. They have also shipped a large order to Norwalk, O., and Lynchburg, Va.

The Imperial Electric Company, of 1,218 Filbert street, Philadelphia, Pa., will shortly introduce to the trade something entirely new in porcelain specialties, and reports the trade in switches, sockets, and cut-outs as very encouraging.

The Cutter Electrical Manufacturing Company, of 27 S. Eleventh street, Philadelphia, is already receiving many orders for flexible cord. This company will also manufacture a large number of specialties on a large scale, commencing at once.

J. W. Parker & Co., of 38 S. Fourth street, Philadelphia, among recent orders have supplied the following: One 150-h. p. engine, consigned to the Lynchburg Street Railway Company; one 250-h. p. to the Rock Creek Street Railway Company, and one 35-h. p. to the Reading Coal and Iron Foundry.

The Consolidated Electric Storage Company, Drexel Building, Philadelphia, have just completed and shipped the following orders: 168 S. 17 type accumulators to the Williamson Free School; 56 S. 11 type to the Wesleyan University, Middletown, Conn.; 59 of the same type to the university of Vermont, and smaller orders to various parts of the country.

The Easton Electric Company, Brooklyn, N. Y., has just installed another 55 arc light dynamo in the store of Wechsler & Abraham, on Fulton street, that city. This makes the fifth dynamo the Easton company has sold to this well known firm, and the order being given after 18 months' trial of the other four dynamos speaks well for the Easton system. Another dynamo was removed to make room for this latest addition.

Wm. H. Weston & Co., Philadelphia, are selling large quantities of switches and other electrical apparatus. They have just delivered six regulators and resistance coils to the Wheeling (W. Va.) Railway Company, in which over 15,000 feet of wire were used; also, stage regulators and switches for two opera houses in Charleston, W. Va., and Butler, Pa.: ten 600-ampère railroad switches in one order for Vallee Bros. & Co., Philadelphia.

The Western Electric Company, of Chicago, has recently manufactured and placed in position for the Burlington (Vt.) Telephone Exchange a new switchboard of the latest improved multiple system, such as is used in all the chief cities throughout the country. It is arranged in three sections or tables, for three operators, and is wired for 180 circuits, which will accommodate about 700 subscribers. With the system each operator has full control of all lines coming into the exchange, and can answer and call any subscriber from one table.

The Waddell-Entz Electric Company, of 302 Produce Exchange Building, New York City, has taken the contract for the complete wiring and conduit work of the new *Mail and Express* Building which is being erected at the corner of Broadway and Fulton street. The electrical construction work will be done under the supervision of H. Ward Leonard & Co. This is an important contract, and the Waddell-Entz company is to be congratulated on having secured it.

A Twig from a Christmas Tree.—The Mason Regulator Company, of Boston, are remembering their many friends with a Christmas greeting. It is novel and neat, a card bearing an evergreen twig, with the compliments of the company, as follows: "We deeply regret that it is impossible for our many customers to be present with us at our Christmas festivities, but remembering, and desiring to be remembered, we send a twig from our Christmas tree, hoping it will give you 'many, many, merry years.'"

The Electric Appliance Company as general western agent of the Consolidated Electric Manufacturing Company, of Boston, is putting in a very large stock of its celebrated goods. The company's sockets, wall sockets and receptacles are samples of the manufacturer's art. The Davis arc light cut-out, it is said, has proved itself a wonderfully practical piece of apparatus, and is used exclusively throughout Boston by the Boston Electric Light Company. The arc light hanger boards, switches, etc., handled by the company are said to be very desirable articles.

The Eureka Tempered Copper Company, of North East, Pa., manufacturers of pure tempered copper, have recently issued a neat little pamphlet of 15 pages entitled "Long Stories Boiled Down for Busy Men," which are mainly testimonials in regard to the satisfaction given by Eureka Tempered Copper, dynamo brushes, etc. Tempered copper manufactured by this firm was awarded the John Scott legacy and premium in 1890 by the Franklin Institute, of Philadelphia, Pa., as a result of chemical and mechanical examination in regard to the purity of the metal used. The Sub-Committee of Science and Art stated in making the award that they were of the opinion that the Eureka tempered copper had make a decided step in advance in the preparation of copper for many industrial uses, etc.

A bright bit of advertising has recently been put cut by the Security Insulator Company, 136 Liberty street, New York. It consists of a neat circular "About Insulators," and is considered from the standpoint "That a little nonsense now and then is relished by the best of men." Several conundrums and witticisms, and questions to be answered by the reader, are asked in regard to the Security Insulator. The little pamphlet is the result of the efforts of Mr. Alexander S. Brown, of the company, who, as he expresses it, "is not Smith, or Jones, or Robinson, but plain Brown, which appelaltion enables him to be distinguished from the inventor, whose name is Green."

The W. S. Hill Electric Company, of 54 Devonshire street, Boston, has recently issued a supplementary catalogue, bearing the imprint of the Boston and of the New York offices, at 36 Liberty street. This company recently succeeded to the business of W. S. Hill in the manufacture of electrical appliances, and the preliminary catalogue just received is for the purpose of meeting the immediate demand of patrons and correspondents, for a price list of the company's goods, and is to be replaced by a larger and more complete work, which will be profusely illustrated, and it is stated will contain many features never before brought out. The preliminary catalogue mentioned is of 15 pages illustrated with cuts of motors, dynamos, cut-out switches, and various other appliances, manufactured by and handled by the W. S. Hill Electric Company.

Messrs. Waldo & Stout is a new firm which has recently started at Bridgeport, Conn., for the purpose of making new alloys of copper, with aluminium, silicon and manganese, or as their business card reads: "Founders in aluminium, silicon and manganese bronze." The firm is composed of Dr. Leonard Waldo, until recently connected with the Aluminium, Brass and Bronze Company, of Bridgeport. Mr. Stout, of New York, will have charge of the foundry affairs of the company. The new foundries are being erected, and it is expected that the plant will be in operation by the early summer. The buildings will be very extensive, and will be built with all the latest appliances for the making of the very finest castings of these alloys. Mr. Edward S. Sperry, formerly of the Sheffield Scientific School at New Haven, will act as superintendent of the foundry.

The Wadams Oil and Grease Company, of Milwaukee, Wis., manufacturer of Graphite track grease, recently received the following letter from Joseph M. Patten, general manager of the Topeka (Kan.) Rapid Transit Railway Company: "We have used your Graphite track grease for the past three years, to the exclusion of all others. We have tried the various kinds of curve and track greases, and although sold at somewhat less price than your Graphite grease, we find yours the more economical, as it requires less and lasts much longer, the Graphite seeming to fill the pores of the steel and to give a smooth and polished surface. We consider it expressly valuable on cast iron, such as switch plates and cast iron curves, for the above reasons. We have an unusually large number of curves in our road, and some of very sharp radius, and have found it saves us much expenditure of power at our station."

The Electric Merchandise Company, of Chicago, recently received an order for four sets of Burton electric heaters from the Aspen Mining Company, Aspen, Colo., to be used in warming that company's motor stations. Orders have also been received for heaters from the Benson & Halcyon Heights Railroad Company, of Omaha, Neb.; Edison General Electric Company, of Portland, Ore.; Maschinenfabrik, Oerlikon bei Zurich, Switzerland; Newburyport & Amesbury Horse Railroad Company, of Newburyport, Mass.; Warrensburg Electric Light Company, of Warrensburg, Mo. The following letter from Mr. A. H. Hayward, superintendent of the Allentown & Bethlehem (Pa.) Rapid Transit Company speaks for itself. He says: "Please ship eight more electric heaters with switches, being the equipment for two cars same as we had before. They are giving excellent satisfaction and are liked by the patrons of the road much better than the stoves."

Alexander, Barney & Chapin, 20 Cortlandt street, are showing a great many toy motors, telephone instruments and a large number of instructive books, arranged under their Christmas tree in their show windows, illuminated by red, white and blue incandescent lamps. The show is attracting a great deal of attention from visitors and purchasers calling at the establishment. At the present time when so many toys are being exhibited in all show windows it is interesting to know that electricity contributes a great deal to the amusement and instruction of children, who are anxiously awaiting the time for hanging their stockings upon the chimney piece for their Christmas gifts. Alexander, Barney & Chapin have recently made many improvements in their store, which they have been compelled to enlarge three times since going into business. The recent improvements consist in the tearing out of the offices in the front of the store, and placing in shelves and counters, thereby not only getting increased room, but admitting light.

The La Roche Electric Works, of Philadelphia, has just completed a fine calibrating direct current dynamo for Messrs. Queen & Co., of that city. This machine is said to be the finest in point of electrical construction of any in the world. The specifications called for a range of from 1 to 1,000 volts; but when it was tested at the La Roche Laboratory, and also the Queen Laboratory, it was found to have a range from 1-50 of a volt to 1,200 volts. When a galvanometer voltmeter was placed in circuit, the needle was brought back to 0 and remained at that point while the machine was at all times running at full speed. It can be readily seen that an armature to develop 1,000 volts would require a large number of turns of wire, and such an armature revolving in a field at full speed without any current going through the fields whatsoever would develop about 40 volts, on account of the residual magnetism of the iron, but this difficulty has been overcome by Mr. F. A. La Roche. This machine is to be used by Queen & Co. to calibrate the fine instruments made by them.

Tests of Insulating Materials have recently been made by the Pacific Insurance Union, which controls the entire insurance work on the Pacific Coast, under the direction of Mr. Geo. P. Low, electrical inspector, who, in a recent letter to the Paraffine Paint Company, of San Francisco, manufacturers of the Pacific insulating compound of the Pacific Coast, and for the territory west of the Rocky Mountains, among other things states the following: "Permit me to express appreciation for the inestimable benefit you have conferred upon the electrical industry in perfecting and bringing out your P. & B. electrical compound. I know of nothing in the form of insulating compound for all around work that is comparable to it." The tests which were mentioned above as having been made by Mr. Low were for determining on the electrical insulation for the wiring of buildings, which was done for the Insurance Union, as electricity is becoming so extensively used for buildings on the coast, and as a result of the test it is now compulsory that P. & B. be used in all electrical work which comes under the Pacific Insurance Union. The Pacific Postal Telegraph Company is painting its wires on the Pacific coast with P. & B., it having been demonstrated that wires so painted have worked perfectly during the heaviest rains and the densest fog.

The Success of the Successful.—The year 1891 has been an "off year" in commercial circles, and but slight activity has prevailed in many lines or industry. But in the "timber town" of Eau Claire, where three years ago some shrewd Wisconsin capitalist s

erected a factory and commenced the manufacture of electric lighting apparatus, the most gratifying conditions have prevailed and the operatives of the National Electric Manufacturing Company have been employed on overtime work almost every night throughout the year. Watchful supervision noted every detail in the apparatus thus turned out, and which, on completion, was packed and shipped to various users in our own country, from Portland, where codfish and cream abound, to its namesake where salmon are served; to the home of the Mongolian, to the country of the Czar, and, in fact, to every part of the world. The total shipments have included the complete direct current apparatus; transformers ranging from one light to 500 lights capacity; alternating current apparatus with the various essentials necessary to complete a system in all its details; alternating ampère meters of simple character and strong constructions having no springs or other similar mechanism apt to get out of order; potential indicators, enabling the dynamo tender even when at a distance to note the drop in potential, a simple device in which two solenoids are in series with a pilot lamp and cut in or out of circuit a red and a blue lamp, as gain or drop may be indicated; multipolar generators of 40,000 watts capacity, designed for special work and compounded for constant potential at 110 volts when feeding current to the lamps, a potential of 140 volts when shunted and sending current into storage cells, and sending a pressure of 125 volts through the circuits when simultaneously feeding both lamps and storage batteries; direct current generators having automatically moving field coils controlling the output and reducing cost of operation; and other apparatus designed for special work. To supply the demand that has been created through liberal and judicious management, the factory has been taxed to its utmost limit and every foot of available floor space is utilized, though extensions have been made from time to time. Thus the directors are well satisfied with the large volume of profitable business transacted and with the excellent reputation for honorable, broad gauge transactions the company has gained under its present able management.

Business Notices.

Complete Equipment of electric light and power plants with the Mather system. Also agent for the Perkins' incandescent lamp. E. T. Pardee, 14 Butler block, Syracuse, N. Y.

Battery Cut-Out, Cheap.—Sensitive, reliable, never requires attention. Gas lighting much improved by its use. Electric Supply Company, of 105 South Warren street, Syracuse, N. Y.

OUR ILLUSTRATED RECORD OF ELECTRICAL PATENTS.

U. S. PATENTS ISSUED DEC. 15, 1891.

11,210. Electric Motor; (Reissue.) Application for reissue filed Oct. 26, 1891. Original patent, No. 441,954, dated Dec. 2, 1890. Henry Groswith, of Philadelphia, Assignor by direct and mesne assignments to the Kennedy-Groswith Electric Company, of same place. In an electric motor, the combination of an armature core wound with two sets of coils, two commutators, brushes, a field magnet having two sets of coils, one terminal of each set being connected to one brush of its respective commutator and to a common conductor, and the other terminal of each set of field coils being connected to the other corresponding brush and to a contact or binding post for external connection.

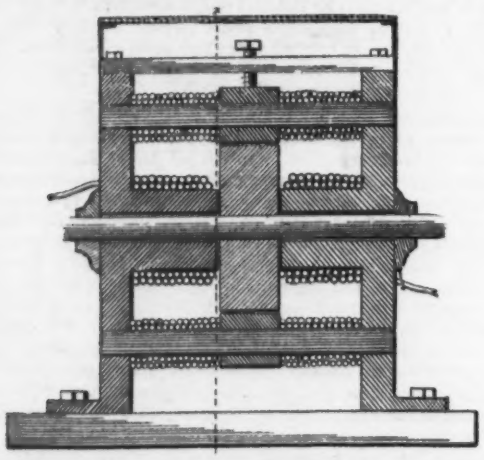
464,955. Means for Propelling Boats by Electricity; Otto Büsser, of Oderberg, near Berlin, Germany. Application filed Feb. 10, 1891. The combination, with a water-way, a continuous cable in the water-way and an insulated line wire, of an electric motor, a cable wheel, a worm, and a worm-wheel operatively connecting the said motor with the cable wheel, and a supporting base plate adapted to be clamped to a boat, and a branch wire and traveling contact-trolley for conducting the current from the line wire to the motor.

464,959. Telephone; Charles Cuttriss, of New York. Application filed July 22, 1891. In a telephonic transmitter, with a diaphragm, of a resilient resistant conducting strip included in the circuit by the connection of its two ends to the diaphragm, and a stationary terminal support, respectively, the said strip being bent or wound upon itself spirally in such manner that by the vibration of the diaphragm its convolutions will be closed upon themselves, and to a greater or less extent in accordance with the amplitude of such vibrations. (See illustration.)

464,979. Electric Signaling Apparatus; Geo. E. Miller, of Lynn, Mass. Application filed April 3, 1891. The improved electric railway signaling device, consisting of an insulated duplex and alternately broken conductor, combined with an engine or train having a battery or electric current generator, a sweeper electrically connected to said battery and conductors, a galvanometer connected to the ground, and a key for cutting out the battery and establishing a connection from the conductors through the galvanometer and to the ground.

464,986. Electric Conductor; William E. Oehrle, of Philadelphia, Pa., Assignor to Oehrle Bros. & Co., of same place. Application filed Sept. 14, 1891. A flexible electric conductor consisting of a core covered with an insulating material, a moisture-repellant material, and an insulating fireproof material and having an interposed protective coating between the moisture-repellent material and the fireproof material.

465,034. Electric Car-Brake; Edmond Verstraete, of St. Louis, Mo., Assignor of one-half to Peter M. Kling, of same place. Application filed Feb. 5, 1891. In an electric car-brake, the combination of the frame, a sliding cross-head, a magnet secured to the cross-head, and a sectional solenoid, one of said sections being larger than the others.



No. 465,104.—DYNAMO-ELECTRIC MACHINE.

465,039. Portable Electric Lamp Holder; John Baker and Henry S. Graham, of Indianola, Ia. Application filed March 5, 1891. A portable electric lamp holder and reel combined, comprising a reel having a crank attached thereto for winding a conducting wire thereon, a cylindrical shaped case having means at its lower end for attaching an electric lamp thereto, and a double hinged hook at its top to admit the conducting wire as required to suspend the device in a vertical or upright position, and also to suspend the device from a nail or hook projecting from a wall or ceiling or other support.

465,046. Automatic Circuit Breaker; William R. McLain, of Des Moines, Ia. Application filed Sept. 18, 1890. Renewed Nov. 10, 1891. In an automatic circuit breaker a base plate of non-conducting material, conducting pieces secured to the base plate, to which the leads of the circuit are connected, a pair of arms pivotally fixed to said conducting pieces, springs, the one ends of which are rigidly fixed to the base plate and their other ends secured to the pivoted arms, a fusible wire inserted in said arms, and set-screws removably held in the ends of the pivoted arms adapted to adjustably secure the fusible wire, whereby the latter may be severed at predetermined strengths of current.

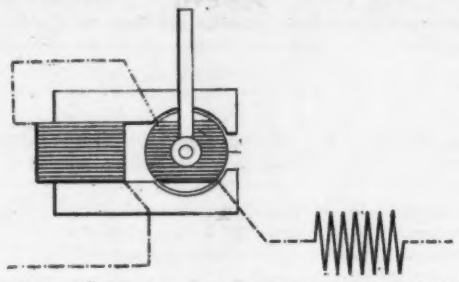
465,078. Method of Controlling Alternating Current Induction; Elihu Thomson, of Lynn, Mass. Application filed April 17, 1889. The method of controlling the flow of current in an alternating-current circuit, consisting in varying the angle of the magnetic axis of two coils placed in said circuit and in inductive relation to a substantially closed magnet circuit of iron. (See illustration.)

465,089. Riveting by Electricity; Elias E. Ries, of Baltimore, Md., Assignor to Ries & Henderson, of same place. Application filed Sept. 15, 1888. The method or process of riveting which consists in heating the rivet when inserted in the rivet hole or holes to the required degree of incandescence by the passage through the same of an electric current of suitable quantity and tension, then heading the rivet and maintaining the same in the desired state of incandescence by suitably regulating the current during the heading operation.

465,093. Electric Belt; Andrew Erikson, of Hawley, Minn., Application filed June 25, 1891. The combination, with an electro-galvanic belt, of the contact plates secured on the inner side of the belt, the spring clasps on said plates being on the outer side of the belt, the metallic flexible conductor extending entirely around the belt and arranged above the spring clasps, the ribbon fastened to the belt and running over the conductor, and a series of cells loosely connected together, and to the conductor.

465,104. Dynamo-Electric Machine; William P. Wiemann, of Allegheny, Pa. Application filed Dec. 30, 1890. In a dynamo-electric machine, the combination of iron end plates having rigid field magnet cores, the shaft passing through said cores and carrying the magnetizable iron mass, the exciting coils wound on the field magnet cores, the armature having the cores formed by bundles of soft iron, which are secured to the end plates, the pole pieces fixed to the cores in the plane of the iron mass, the braces rigid with the end plates and with the armature cores or pole pieces and the casing. (See illustration.)

465,202. Coupling for Electric Conductors; William C. Preston, of Providence, R. I., Assignor of one-half to Richard A. Bright, of same place. Application filed April 27, 1891. A coupling or joint for electric or other wires, consisting of a current-conducting sleeve or casing adapted to receive two or more pieces of wire, and having oppositely-aranged or radiating wedge-shaped recesses formed in the shell, and a wedge-shaped key or keys adapted to be forced into said recesses, and engage the corresponding ends of the wires.



No. 465,078.—METHOD OF CONTROLLING ALTERNATING CURRENT INDUCTION.

465,206. Packet or Pad for Electric Batteries; Lewis H. Rogers, of Brookline, Mass. Application filed Feb. 20, 1891. A packet or pad for an electric cell, consisting of a casing or envelope of absorbent material adapted to be placed between, and to rest against both the positive and negative elements of the cell, said casing containing a charge of electrolytic chemical, which chemical dissolves and forms the active material of the cell when the pad is moistened.

465,212. Feed-Water Regulator; Geo. W. Schilling, of Philadelphia, Pa. Application filed Jan. 27, 1891. A boiler having a water-gauge with float, a supply pipe with a valve therein, a pipe leading from the steam portion of the gauge to the valve-chamber of the supply pipe, an electric circuit containing an electromagnet, and a contact piece, connected with said float for opening or closing the said steam pipe.

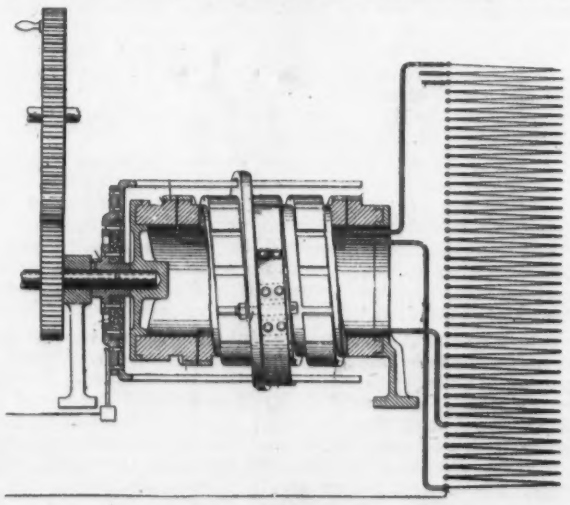
465,218. Adjustable Rheostat; Frank J. Sprague and Charles R. Pratt, of New York. Application filed Aug. 28, 1891. The combination, in an adjustable rheostat, of a series of contact plates spirally arranged and a relatively moving switch contact adapted to co operate with said contact plates. (See illustration.)

465,233. Commutator Connection for Dynamo-Electric Machines; Carl O. C. Billberg, of Philadelphia, Pa. Application filed Oct. 7, 1890. The combinations in a dynamo-electric machine or motor, of a commutator strip, a projection thereon, a plate secured to said projection, orifices in said plate, an armature wire permanently secured in one of said orifices, and an armature wire detachably secured in the other orifice.

465,234. Brush Holder for Dynamo-Electric Machines or Motors; Carl O. C. Billberg, of Philadelphia, Pa. Application filed April 25, 1891. The combination of the commutator brush of a dynamo-electric machine or electric motor, a slide on which said brush is clamped, a rod secured to said slide, a frame having bearings for each end of said rod, and a spring acting on said slide and tending to protect the same.

465,278. Electrical Sewer Gas Indicator; James J. Lawler, of Scranton, Pa. Application filed March 4, 1891. An indicator or signal connected to a sewer or water closet pipe and having a flexible or elastic diaphragm or membrane, in combination with a suspended contact point and the screw adapted to engage said contact point and to be manipulated by hand, and means for sounding an alarm, as the contact screw and point come into engagement.

465,292. Electric Motor Switch; Edwin Wilbur Rice, Jr., of Lynn, Mass., Assignor to the Thomson-Houston Electric Company, of Connecticut. Application filed March 28, 1889. The combination, with an electric motor on a constant potential main, of a rheostatic switch and main switch, an independently pivoted actuating handle, and a retracting spring for opening the main switch when the motor is to be thrown out of circuit.



No. 465,218.—ADJUSTABLE RHEOSTAT.

465,349. Magnetic Ore Separator; Clinton M. Ball, of Troy, N. Y. Application filed Dec. 11, 1890. An ore separator comprising a rotary screen in a magnetic field, means for passing the ore to the screen, and means for varying the strength of the field.

465,359. Converter System for Electric Railways; Mark W. Dewey, of Syracuse, N. Y., Assignor to the Dewey Corporation, of same place. Application filed May 11, 1891. In an electric railway, a source of irregular or alternating currents, conductors extending therefrom, a series of coils placed at intervals along said railway and connected in parallel with said conductors, normally closed magnetic circuits for the coils, a vehicle, a conductor upon the vehicle to be placed in inductional relation to the magnetic circuits successively, said conductor being entirely movable, and an electric motor to move the vehicle in circuit with the latter conductor.

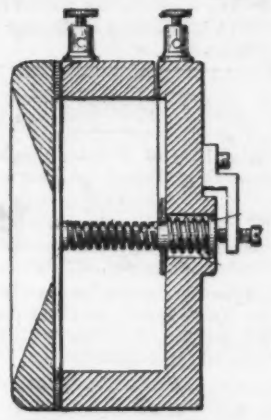
465,360. Electric Fan; Philip Diehl, of Elizabeth, N. J., and Edwin H. Bennett, Jr., of Bayonne, N. J. Application filed April 4, 1891. A suspended electric fan provided with a tubular support forming a conduit for the conductor, combined with a motor-support attached to said tubular support, and a tube attached to said motor-support and serving as a bearing for the rotary armature-carrier and as a conduit for the passage of conducting wires running to brush-holders arranged below the armature.

465,361. Electric Fan; Philip Diehl, of Elizabeth, N. J., and Edwin H. Bennett, Jr., of Bayonne, N. J. Application filed April 8, 1891. An electric fan having a depending tubular support, provided at its lower end with a supporting piece for the field magnet; a stationary shaft fixed to said supporting piece, a rotary armature having its bearing on said stationary shaft, a supporting rod within said tubular support, and a locking device for securing said rod and tubular support together.

465,396. Train Signaling Apparatus; Paul Synnestvedt, of Chicago, Ill. Application filed April 27, 1891. The combination, in a train signaling apparatus, of reservoir with an electromagnetic signal valve provided in direct connection therewith, the electromagnet of said valve, two wires or strands extending therefrom through the train, means for uniting the rear ends of said strands, a battery located on one of the cars and included in one of said strands of the circuit, said strands in each car formed into a single cord extended between the ends thereof, a circuit breaker provided in each car and adapted to be operated by a pull exerted upon said cord, said circuit breakers consisting in two electrically connected levers or bars having their free ends connected with said cord, binding posts, having fingers adapted to make contact with said levers, one strand being cut and having its ends secured in said binding posts, and means for normally holding said levers in contact with said fingers.

465,404. Switch-Actuating Mechanism for Electric Motors; Chas. G. Armstrong, of Chicago, Ill. Application filed May 11, 1891. The combination of an electric motor, a rheostat adapted to control the passage of the electric current thereto, a means for actuating and regulating the movement of the rheostat brush, an electro-mechanical device in a shunt to the main circuit for throwing said actuating means in operation, and a second device constant and independent of the first device, such as a spring, for reversing said actuating means upon the cessation of action of said electro-mechanical device.

465,407. Electric Railway; Geo. F. Green, of Kalamazoo, Mich., Assignor by direct and mesne assignments to Oliver S. Kelly, of Springfield, O. Application filed Sept. 15, 1879. The combination of a railway track, one or more stationary electric batteries, electrical conductors extending from said batteries along the lines of said track, and consisting wholly or in part of the rails thereof, vehicles moving along said track, electro-dynamic motors whose coils are constantly excited so long as the poles of said motors are in circuit with the electric batteries fixed upon said vehicles for imparting motion thereto, and wheels supporting said vehicles upon the track, and also serving to maintain continuous electrical connection between said batteries and motors.



No. 464,959.—TELEPHONE.

465,423. Electric Heater; Warren H. Boles, of Syracuse, Assignor of one-half to George E. Waldron and John H. Reynolds, of Troy, N. Y. Application filed March 21, 1891. In an electric heater, the combination of a tube having a solid peripheral wall formed with perforations there through and a resistance conductor wound spirally around said tube.

465,426. Electric Switch and Case for the Same; Curtis P. Chappell, of Providence, R. I., Assignor to the Household Sewing Machine Company, incorporated, of same place. Application filed Nov. 4, 1891. The invention consists of a casing having a hinged lid which fits the casing closely and rests upon a packing ring. Inlets are formed in the casing and extend in an upward direction, a lever operates in a slot in the base and is provided with a spring secured to an eye in the inner end and to a stud in the bottom of the casing.

465,430. Electric Connector; William F. Z. Desant, of New York. Application filed May 20, 1890. A connector or coupler for an electric circuit, consisting of two metallic or conducting parts secured to the ends of the circuit-wire, one of said parts having a conducting socket and surrounding shield and the other a conducting plug and sustaining shoulders, which fit snugly inside the surrounding tube.

465,432. Electrical Railway; Geo. F. Green, of Kalamazoo, Assignor by direct and mesne assignments to Oliver S. Kelly, of Springfield, O. Application filed May 15, 1886. The combination of one or more stationary sources of electric current, a conducting circuit formed wholly or in part of insulated conductors extending along the line of travel of said vehicle, one or more rotating electric motors mounted upon said vehicle for propelling the same and included in said circuit of conductors, and a circuit-controller placed on said vehicle and also included in said circuit of conductors.

465,442. Electrical Indicating Instrument; Edward Weston, of Newark, N. J. Application filed March 11, 1891. The combination, in an electrical indicating instrument, of a coil supported so as to be axially movable, a means of producing a permanent field of force around said coil, and a means independent of the coil-support for indicating the extent of the movement of said coil.

Copies of the specifications and drawings complete of any patent mentioned in this record—or of any other patent issued since 1836—can be had for 25 cents. Give date and number of patent desired and address The W. J. Johnston Co., Ltd., Times Building, N. Y.

THE ELECTRICAL WORLD

AN ILLUSTRATED WEEKLY REVIEW OF CURRENT PROGRESS IN ELECTRICITY AND ITS PRACTICAL APPLICATIONS

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Jewell Belting Co.
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Reddaway & Co., F.
Schieren & Co., C. A.
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Harrison Safety Boiler Works.
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Lincoln Electric Mfg. Co.
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Ostrander & Co., W. R.
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Wires and Cables, Mfrs. of.
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Waddell-Entz Electric Co.
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Woodwork (Electrical).
Johnson, Russell.
Union Hardware Co.
Zinc.
Kles, K. L.
Illinois Zinc Co.

Alphabetical Index to Advertisers.

Alexander, Barney & Chapin.... i
Aluminium Carbon Co xxxviii
Amer. Bell Telephone Co..... xxxi
Amer. Circular Loom Co i
Amer. Electric Elevator Co..... xxvi
Amer. Electrical Works..... iii
Amer. District Steam Co..... x
Amer. Watch Tool Co..... xxiii
Anderson, Albert & J. M..... xxvi
Andrae Julius..... xxii
Appleton, T..... xxi
Armington & Sims Engine Co. xxxviii
Atlantic Covering Co..... xx
B. & S. Electric Equipment Co.. xxxvi
Babcock & Wilcox Co..... —
Baker & Co..... iii
Bain, Force..... xxxi
Ball Engine Co..... xxxv
Ball & Wood Co..... xxii
Baragwanath & Son, Wm..... xxi
Barnes Co., W. F. & John..... xxvii
Barr Pumping Eng. Co..... —
Baxter, H. E. & C..... xxx
Beggs Mfg. & Supp. Co., J. E... xxii
Belknap Motor Co..... —
Bell Telephone Co. of Canada xv
Benham & Schindel iii
Berlin Iron Bridge Co..... xxxi
Bernstein Elec. Co..... xvii
Betts Machine Co..... xxii
Billings & Spencer Co..... iv
Bishop Gutta Percha Co..... —
Blauvelt Mfg. Co..... iii
Bogart, A. L..... i
Boker, Hermann i
Boston Bridge Works..... xxiii
Bowers Bros..... xxi
Bradbury-Stone Storage Batty Co. iii
Bridgeport Mach. Tool Works.. xxi
Brill Co., J. G xvii
Brookfield, Wm..... xxviii
Brown, J. Stanford..... xxi
Brush Electric Co..... xii
Buckeye Electric Co..... xxviii
Buckeye Engine Co..... xxxv
Bunnell & Co., J. H..... xxxvi
Burnham & Duggan..... xxvi
Butler Hard Rubber Co..... xxiii
C. & C. Electric Motor Co..... xxx
Chandler & Taylor Co..... xxxiii
Cary, Alanson..... xxvii
Cameron Stm. Pump Wks. A. S. xxxvi
Chase, M. C..... xxviii
Clark, Edred W..... xii
Clark Electric Co..... viii
Colburn Elec. Mfg. Co..... xxxvi
Columbia Incandescent Lamp Co. xvi
Colwell Lead Co..... xxxi
Conover & Co..... —
Cons. Electric Mfg. Co..... xvii
Cons. Temp. Controlling Co..... —
Cornell Electrical Eng. Co. xxviii
Crane, W. E..... —
Crescent Ins. Wire & Cable Co. xviii
Crocker-Wheeler Motor Co..... xxviii
Dallett & Co., Thos. H..... xxix
Danks & Co..... —
Day & Co., R. L..... xxvii
Dean Bros. Steam Pump Works xxxiv
Delaware Hard Fibre Co..... xxvii
Dixon Crucible Co., Joseph..... iv
Eastern Electric Cable Co ..... —
Eastern Electrical Supply Co... xii
Easton Elec. Co..... —
Eckert, W. H xxxvi
Eclipse Clutch Works..... xxxv
Economic Electric Mfg. Co..... xvi
Eddy Electric Mfg. Co..... xv
Edes, E. L..... xxv
Edison General Electric Co..... ix
Electric Appliance Co..... iv
Electric Construc. & Supply Co.. xiv
Electric Engineer. & Supply Co. xxviii
Electric Merchandise Co xviii
Elec. Secret Service Co xv
Electrical Supply Co., The xi
Electrical Construction Co..... xxi
Elektron Mfg. Co., The..... x
Emerson Electric Mfg. Co..... —
Empire China Works..... iii
Esterbrook Steel Pen Co..... xxvi
Equitable Engin. & Cons. Co..... xxv
Eureka Tempered Copper Co. xxxvi
Excelsior Elec. Co..... xvi
Falls Rivet & Machine Co xxxiv
Felt & Tarrant..... —
Fidelity Carbon Mfg. Co..... xxxvi
Fishkill Landing Mach. Co..... —
Fitchburg Steam Engine Co... xxxiii
Fletcher & Fletcher Elec. Co.. iv
Ford & Washburn Elec. Co..... —
Forest City Electric Works.. xvii
Frink, I. P..... xxxi
Frisbie Co., D..... xxxiii
Ft. Wayne Electric Co..... xviii
Gardam & Son, Wm..... xxi
Garvin Machine Co..... iii
Gibson Electric Co..... xxxvii
Gill, John L..... xxxiv
Globe Carbon Co..... xxx
Goodrich Hard Rubber Co ..... —
Goodrich & Co., B. F..... —
Gordon & Co., W. H..... i
Gordon, Strathy & Co xxxiii
Gould & Eberhardt..... xxxvi
Gould & Watson Co..... xviii
Grant & Co., J. A..... xxxii
Graphite Lubricating Co..... xxxii
Greeley & Co., The E. S..... i
Greene, Tweed & Co..... xxxii
Gt. Western Elec. Supply Co.. xxix
Hadley Co..... xvii
Hall Signal Co, The..... xx
Haines, Jones & Cadbury..... xxxiii
Harrisburg Foundry & Mach. Co. xxiii
Harrison Safety Boiler Works .. iii
Hart & Hegeman Mfg. Co..... xxiii
Hartman & Braun..... xxx
Hazelton Boiler Co..... xxxv
Heisler Electric Light Co..... —
Heine Safety Boiler Co..... xxiv
Hill Clutch Works..... iv
Hill Elec. Co., W. S..... xxix
Himmer & Anderson xvii
Hinds, C. H xxxi
Hirliman, C. J..... —
Hoenack, Paul..... iii
Holmes, Booth & Haydens..... xxix
Holtzer-Cabot Elec. Co ..... —
Hunt Engineering Co..... xxxvii
Hunter & Sons, Jas..... —
Hutton, Henry..... xxi
Illinois Electric Material Co.... xx
Illinois Metal Co..... xxx
Illinois Zinc Co..... xxvii
Imperial Electric Co..... viii
India Rubber & G. P. Insul. Co... —
Interior Conduit & Insulation Co. xxvi
International Okonite Co., The. xxxii
Jenkins Brothers..... xxxviii
Jewell Belting Co..... xxxiii
John Simmons Co..... xxviii
Johns, Mfg. Co., H. W..... iv
Johnson, Russell..... xxi
Johnston Co, W. J..... xxiv
Jones, Jesse..... —
Jones & Son, J..... xx
Jones & Co., Geo. P..... —
Kim & Brunner..... xxv
Kartavert Mfg. Co..... iv
Kelly & Son, Benj. F..... xxxiii
Kendall & Sons, Edward..... —
Keppy, Fred'k..... xxvi
Keystone Electric Co..... xxx
Kidder Mfg. Co., Jerome..... xxi
Laidlaw & Dunn Co..... xxvii
Laminar Fibre Goods Co..... xviii
Lane & Bodley Co..... xxxiii
Lang & Co., J..... xxvii
Law Telephone Co..... xvi
Leclanché Battery Co..... iii
Leffel & Co., J..... xxviii
Leffel Water Wheel & Engine Co. xxvii
Leonard & Co., H. Ward..... xxiii
Lincoln Elec. Mfg. Co..... xii
Loud & Sons, H. M..... xxvii
Locke Brothers xxxviii
Lunkenheimer Brass Mfg. Co.. xxxiii
Lyman, W. C..... xxxiii
Manhattan Elec. Supply Co..... xxxiii
Marshall, Wm..... xxiii
Massachusetts Elec'l. Eng. Co. i
Mason Regulator Co..... xxxviii
McCollin, T. H..... xxxi
McCreary Elec'l. Spec. Co..... viii
McGowan Co., The John H..... xxxiv
McIntire Co., The C..... iii
McIntosh, Seymour & Co..... xxxviii
McLennan, K..... xxii
McLeod, Ward & Co..... xxiii
Milliken Bros..... xxxvi
Monson Maine Slate Co..... iii
Moore, A. F..... i
Moore & White Co..... xxxiv
Munsell & Co., E..... iii
Munson Belting Co., Chas..... xxxvii
Murphy, T. J..... —
Murray Co., Thomas..... i
Murray & Co., J. J..... xxvi
National Electric Mfg. Co..... vii
National Electric Co., Ltd..... xxx
Nassau Electrical Co..... xxvi
National Carbon Co..... xxv
National Electric Co..... xxviii
National Telephone Mfg Co..... —
National India Rubber Co..... xx
New Process Raw Hide Mfg. Co..... xxx
New England Engine Co..... xxviii
Newton Rubber Co..... xx
N. Y. Carbon Works..... xxxi
N. Y. Ins. Wire Co ..... i & x
N. Y. & Ohio Co..... —
N. Y. Safety Steam Power Co. xxxviii
Northwestern Elec. Spec. Co..... — —
Norton & Jones Mach. Tool Wks. —
Noye Mfg. Co., John T..... xxxvii
Nuttall & Co., R. D..... xv
Ostrander & Co., W. R..... xx
Otis Brothers & Co..... xxxviii
Otto Gas Engine Works..... xxxv
Paiste, H. T..... xix & xx
Partrick & Carter..... —
Pass & Seymour..... xxv
Payne & Sons, B. W..... —
Peck, Barton L..... iv
Peckham Motor & Truck Wheel Co..... xxix
Penrhyn Slate Co..... xvii
Perfect Pencil Pointer Co..... —
Perfection Oil Purifier Co..... xxxiv
Perkins Elec. Switch Mfg. Co.. —
Perry & Noyes xxvii
Pettingell-Andrews Co..... xviii
Philadelphia Eng. Works..... —
Phœnix Glass Co..... —
Phœnix Iron Works Co..... xx
Phosphor Bronze Smelting Co.. xxvii
Pierce Bros. & Co..... xxviii
Pittsburgh Boiler Scale Res. Co. xxxii
Pittsburgh Reduction Co..... xxi
Platt, Chas. S..... iv
Pond Engineering Co..... xxxiii
Purity Oil Filter Co..... xxxiv
Queen & Co., Jas. W..... xxi
Reddaway & Co., F..... xxxii
Redding Electric Co..... xxxi
Reliance Gauge Co..... xxiii
Ries Electric Spec. Co xxv
Ripley, H. C..... xxvi
Roebling's Sons, J. A..... —
Rollason Gas Engine Co..... xxxii
Rose Electric Light Supply Co.. xxii
Ryle & Co., Wm..... —
St. Louis Elec'l Supply Co..... xxviii
Safety Electric Co..... —
Samson Cordage Works..... xx
Santley Lumber Co..... xxxiii
Sargent, J. Bradford..... viii
Sawyer-Man Elec. Co..... xiv
Schawel & Co., Jas..... xxi
Schieren & Co., C. A..... i
Schoonmaker, A. O..... xxxi
Schultz Belting Co..... iv
Schuyler Electric Co..... xxxvii
Scott Elec. Mfg. Co..... xxi
Sebastian-May Co..... xxi
Sessions Foundry Co..... xxvi
Shaw Brothers..... xvii
Shaw & Co., J. Elliott..... xxxi
Shephard, H. L..... xxvii
Short Electric Ry. Co..... xxii
Sieb & Starke..... xxv
Simplex Electrical Co..... i
Sioux City Engine Works..... xxxv
Smith, A. T..... xxxi
Smith & Vaile Co..... —
Solar Carbon Mfg. Co..... xxviii
Somoff, J. L..... —
Southern Elec. Co..... —
Spencer's Sons, I. S..... xxxi
Sperry Elec. Mining Mach. Co. xxii
Sprague, Duncan & Hutchinson..... iii
Standard Carbon Co..... xxvi
Standard Electric Time Co..... xxv
Standard Fibre Ware Co..... xxi
Standard Paint Co xxxvi
Standard Thermometer Co..... xxxiv
Standard Und. Cable Co..... xxxviii
Stanley Electric Mfg. Co..... xi
Star Electrix Co..... xxv
Stearns Mfg. Co..... xxxv
Steele & Johnson Mfg. Co..... viii
Stephenson Co., Ltd., John..... iv
Sterling, W. C..... xxvii
Stilwell & Bierce Mfg. Co..... xvii
Thill's Sons & Co., F..... xxiii
Thomas & Sons, R..... xxvii
Thompson Music Co..... —
Thomson-Houston Elec. Co..... xiii
Thomson-Van Depoele Electric Mining Co..... xiii
Tropical Amer. Telephone Co .... —
Truex & Vail..... xxi
Tucker Elec'l Con. Co..... i
Turner, W. C..... xxii
Underwood Mfg. Co..... xxxii
Union Electric Mfg. Co xxxviii
Union Hardware Co..... xxxi
Union Porcelain Works..... iv
U. S. Electric Lighting Co..... viii
U. S. Electric Railways Co..... xxxviii
U. S. Mineral Wool Co..... xxv
Van Nuis, C. S..... xxi
Viaduct Mfg. Co..... xxxvi
Vulcanized Fibre Co..... iii
Waddell Entz. Elec. Co..... xxvi
Wadham's Oil & Grease Co..... i
Wainwright Mfg. Co..... —
Walsh, Owen..... xxxi
Walworth Mfg. Co..... xxxvii
Wallace & Sons..... xxvii
Warren, Webster & Co..... xxxii
Washington Carbon Co., i, v & xxxviii
Watson & Stillman..... xxxvii
Wemple's Sons, Wm. B..... —
Western Electric Co..... xxxvi
Westinghouse Elec. & Mfg. Co.. —
Westinghouse Machine Co..... xxxv
Weston Elec'l Instrument Co.. vi & xx
White Dental Co., S. S xxvii
Whitmore & Robinson..... i
Williams Engine Co..... xxxiii
Wilmot & Hobbs Mfg. Co..... xxxviii
Wollensak, J. F..... xxvii
Woodbridge & Turner Eng. Co. xxi
Woodhouse & Rawson..... iii
Wyckoff, Seamans & Benedict.. xxxvii
Want and For Sale Ads xxii

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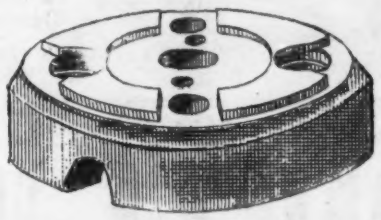

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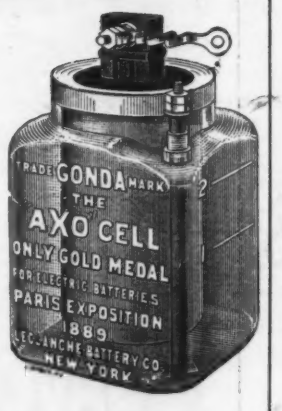

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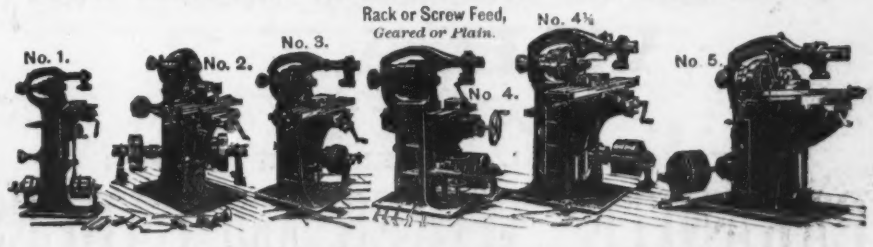

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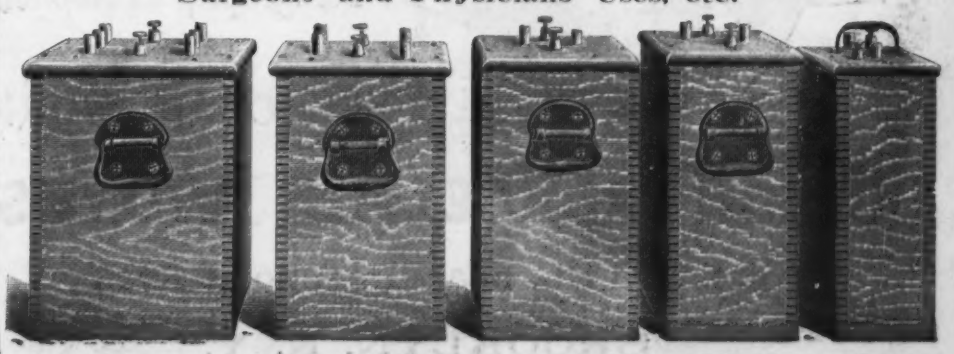

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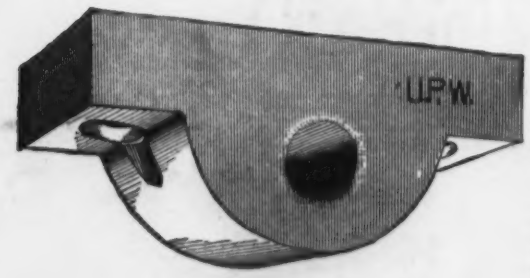

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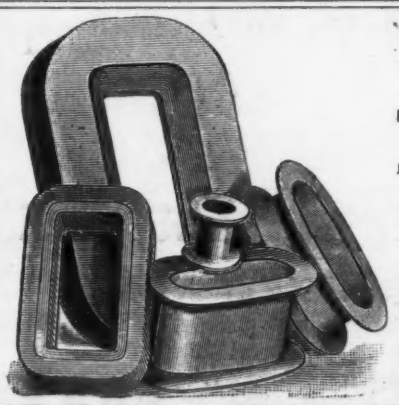

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"The Trust will buy raw material from YOU if you will agree to charge Outsiders 25 per cent. more than you charge the Trust."

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By "Outsiders" it meant the ***Washington Carbon Company.*** *It is part of its creed that no one but the Trust has any right in the business.*

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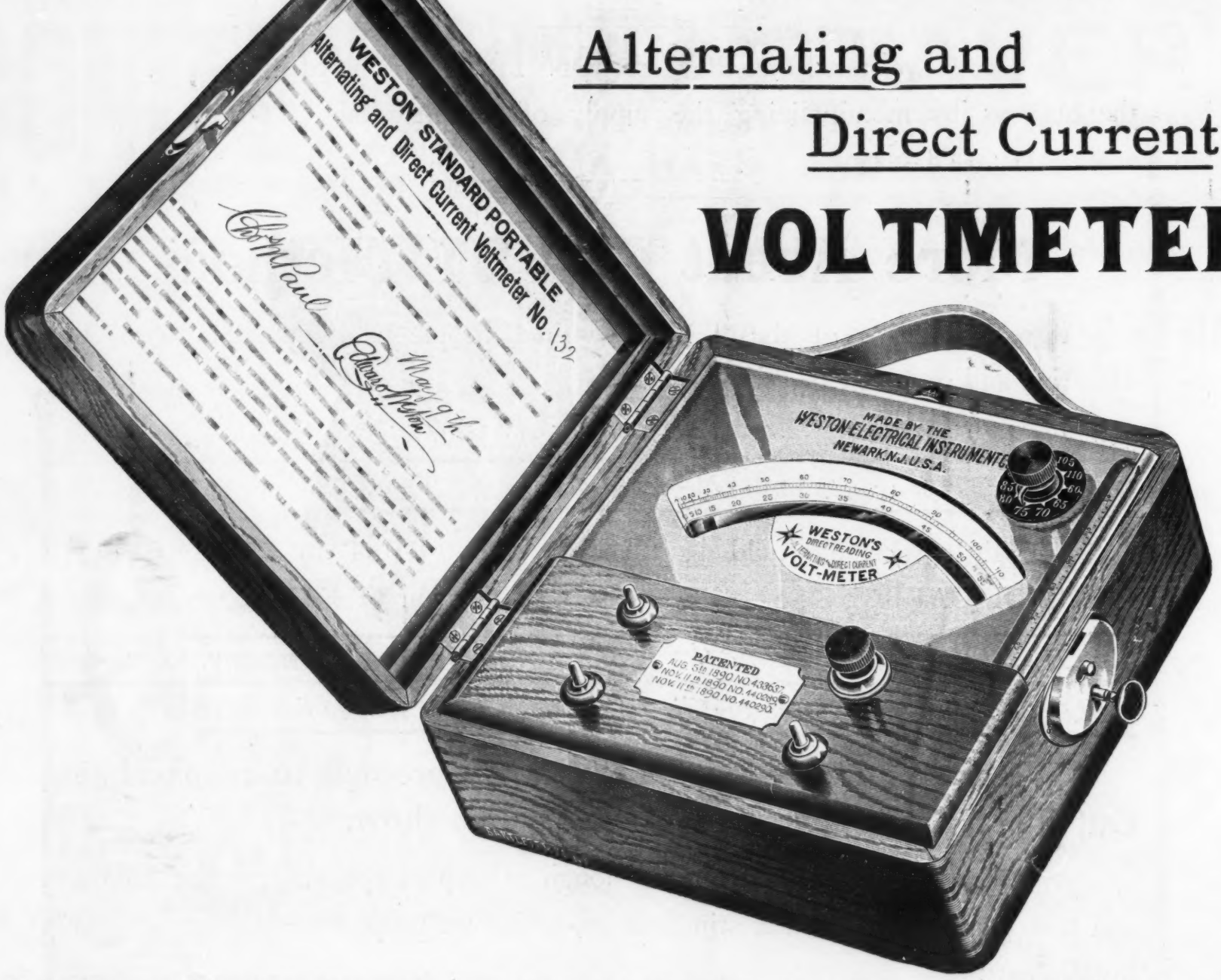

It is adapted for use on *either alternating or direct current circuits,* and its indications will be found perfectly accurate on either, to within one-fifth of one per cent

It has received the most thoughtful study, and every detail has been worked out with extreme care to insure great accuracy, sensibility and permanency; and no pains or expense has been spared in the effort to produce a really reliable and durable instrument for use as a standard in determining potential differences on alternating current circuits, with the widely varying rates of alternations met in practice. It has been subjected to a most exhaustive and long continued series of tests in the laboratory, and has been put to practical use for a long time, in order to discover any weak points, and to eliminate them before offering it for general and extensive use. We now offer it with perfect confidence, and feel assured that when its good qualities become known, it will be gladly accepted as THE Standard Portable Instrument for alternating current work.

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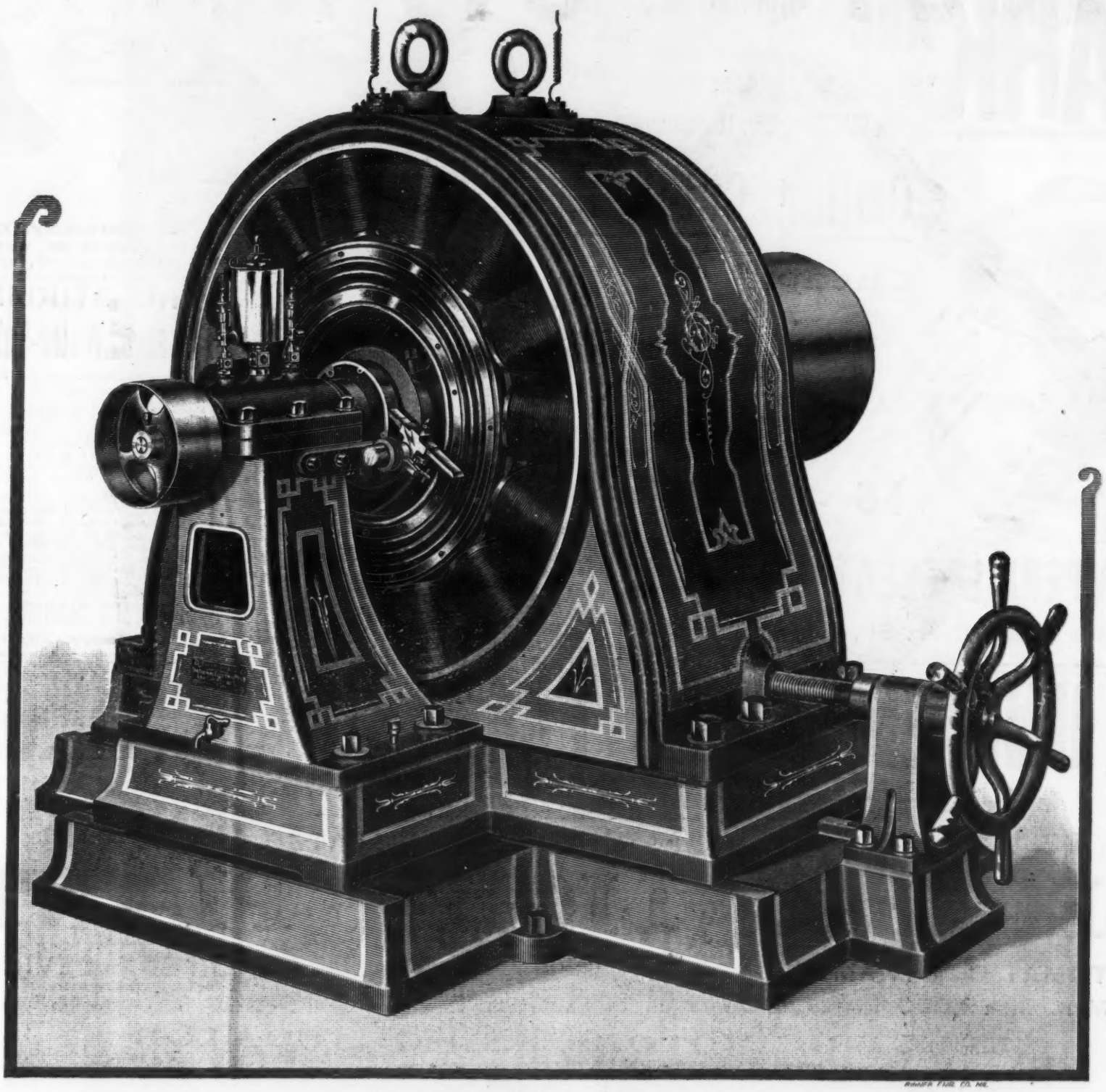

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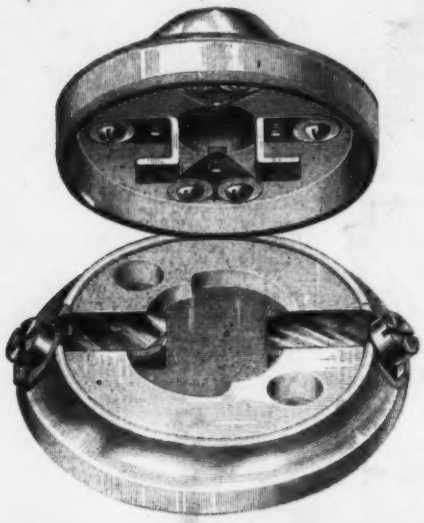

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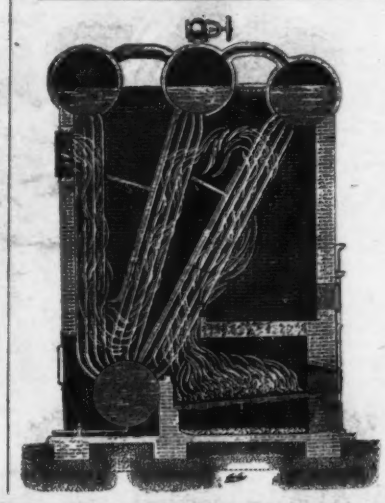

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There is not an ounce of cast iron or cast steel used in its construction. There are no hand-hole plates to leak. The heating surfaces are thin and **always** clean. There is no fire contact with riveted joints.

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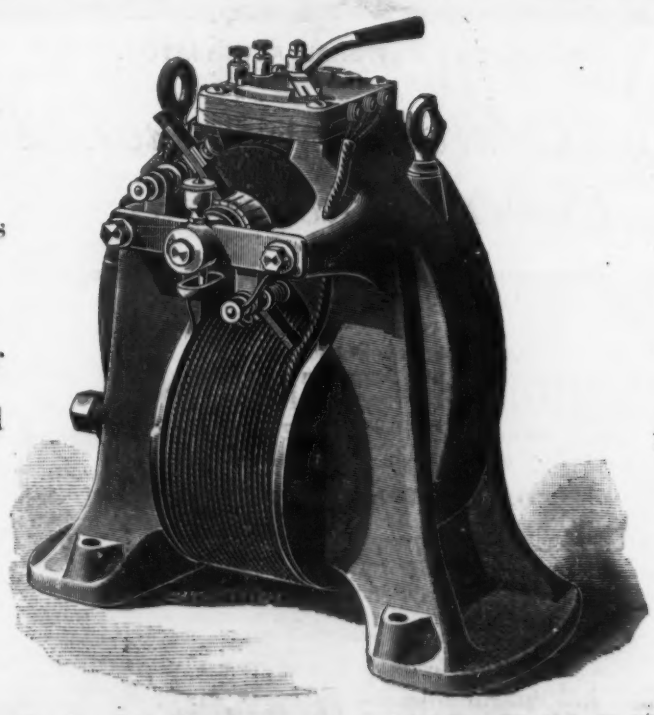

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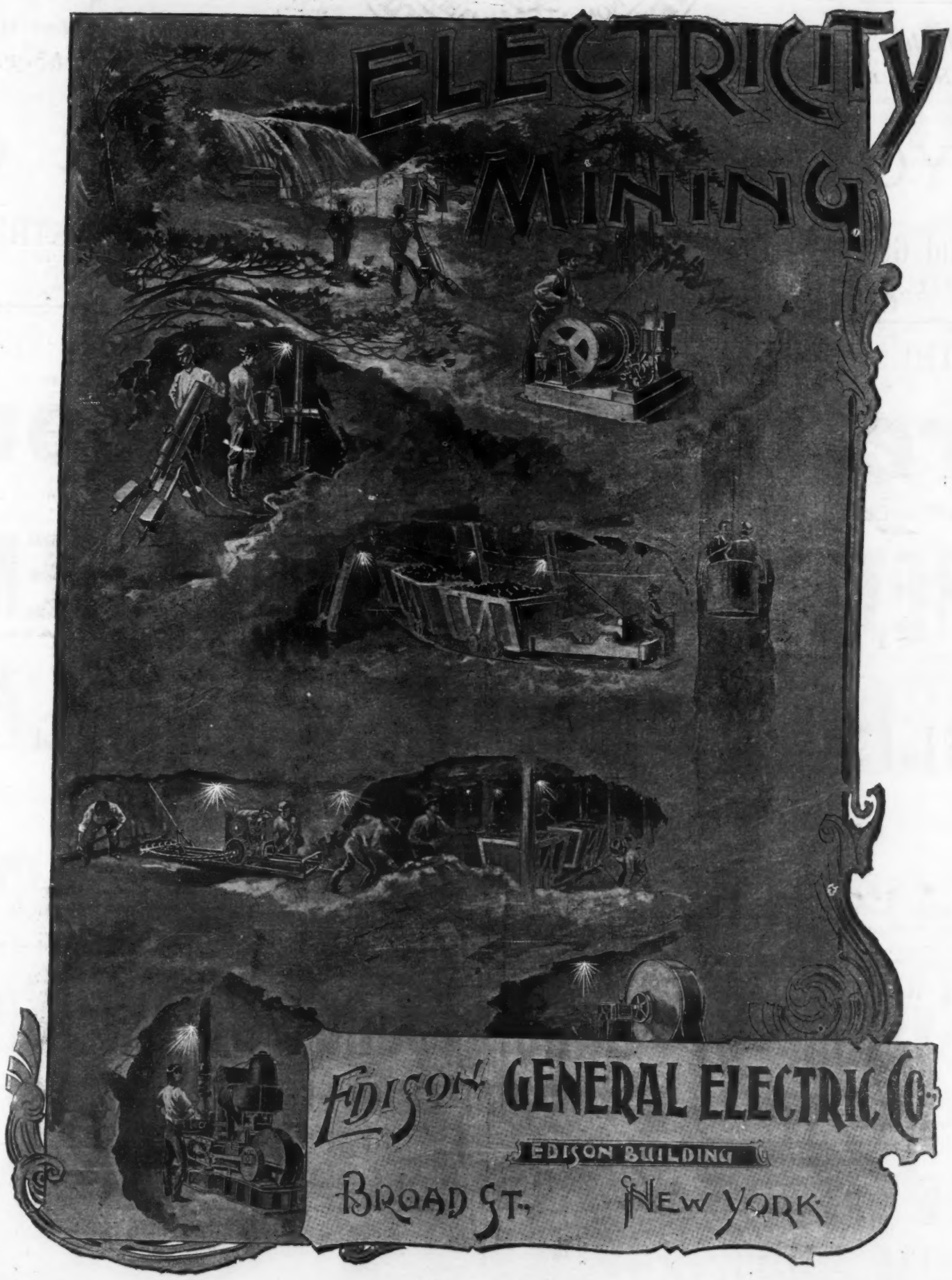
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FOR THE UTILIZATION OF EXHAUST STEAM AT ELECTRICAL STATIONS.

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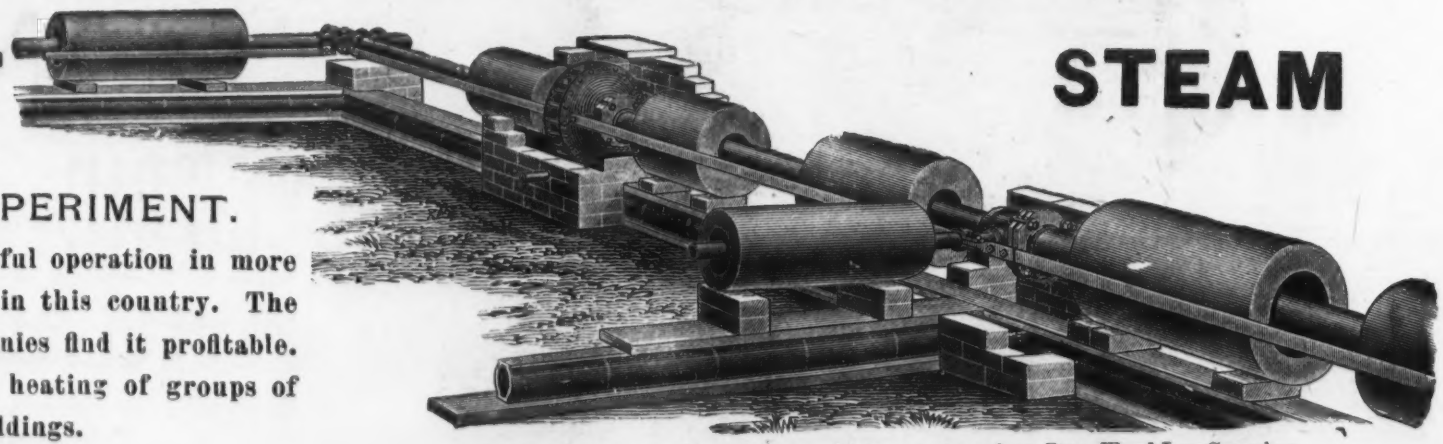

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THIS IS NO EXPERIMENT.

The system is in successful operation in more than fifty cities and villages in this country. The people like it, and the companies find it profitable. Particularly adapted to the heating of groups of college and other public buildings.

ELECTRICAL COMPANIES CANNOT AFFORD TO WASTE THEIR EXHAUST STEAM, which has a value of $3,000 to $5,000 per annum for each 100 h. p. after having been used for generating electricity, and keep the idle men and boilers employed during the hours when not furnishing light, and at but little increased expense. For particulars address

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The ENGINEER: "You see for about three miles along this avenue there is very heavy foliage?"

The PRESIDENT: "Foliage?"

"Yes; that is, trees. You know, since the road has been built, property owners have gone to the expense of transplanting large shade trees and in other ways improving their places."

"Um, quite a natural result; glad to see it, too—it helps the value of our own acres out that way."

"Well, the first feed-wires that we put up are giving us considerable trouble. Rainy days and other times, when we need it the most, we can't get enough current into the trolley to do the work. We had to lay off one motor and trailer yesterday."

"Couldn't you put on another generator?"

"Yes, we did; but the heavy leakage more than offset it. What we need is *insulation*."

"Insulation? Isn't the wire you have up covered?"

"Well, yes, sir, it *is* covered, to be sure, but I am sorry to say that's about all it amounts to."

"Humph! Suppose we do put up other wires, will they be any better? Seems to me we have had a deal of 'putting up' to do lately."

"It does look that way. I think we made a mistake in not buying the best at first."

"Can you get an 'insulated' wire?"

"Oh, yes, there is a kind made that will relieve us of this worry. Old Furbelow was in this morning and threatened to sue us for trimming out his trees"

"Let him sue. What's the name of that wire?"

"Shield Brand Moisture Proof."

"'Moisture Proof'? Is there any difference between that and 'Weather-proof'?"

"A great deal of difference; but the fellow who sold us that 'Weatherproof' stuff said his was just as good."

"And it wasn't?"

"No, sir!"

"Well, get all the 'Moisture Proof' you need and get it quick."

"All right. I'll telegraph The Electrical Supply Co. to-night."

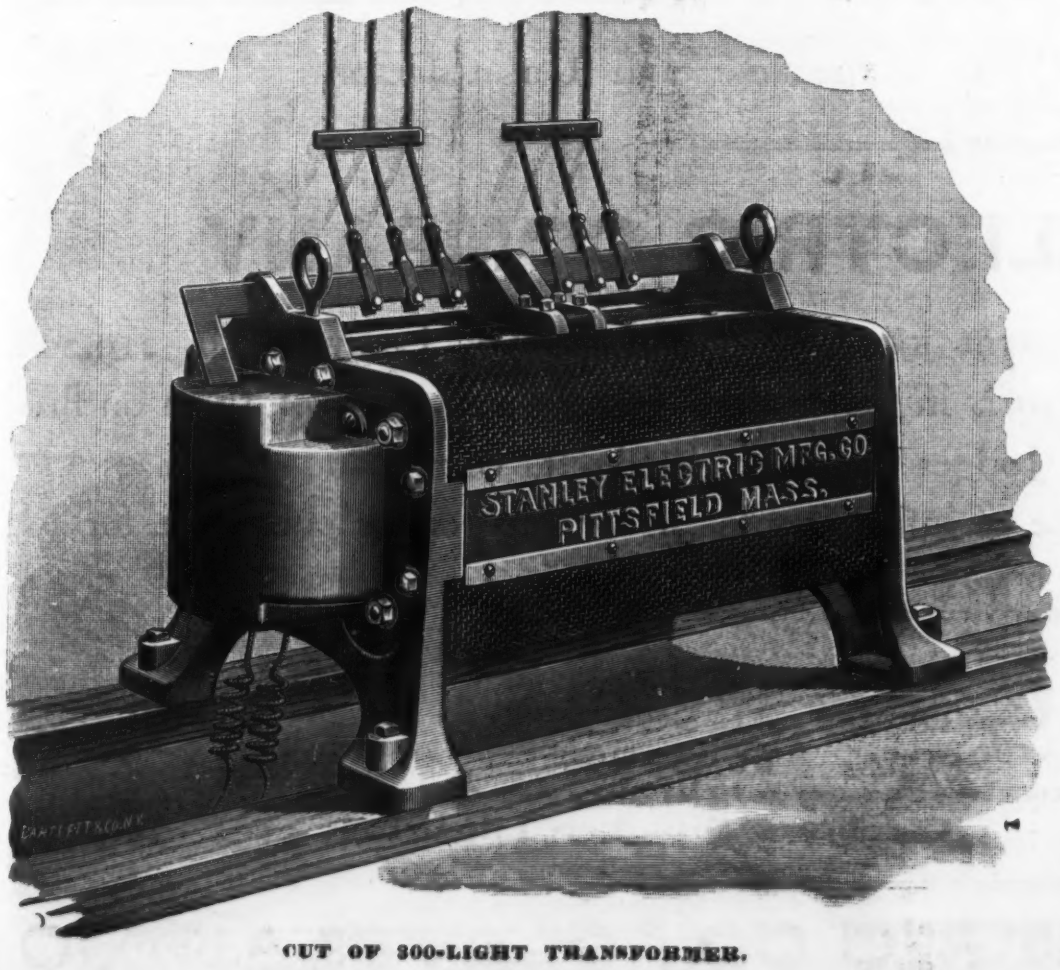
"Chicago?"

"Yes."

TAKING THE LEAD!

Though only on the market for six months, the STANLEY is now known as

THE BEST TRANSFORMER.



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"LET me tip you the wink! If you are after bottom prices, send in your orders for Electric Railway and Electrical Supplies of all kinds to the Eastern Electrical Supply Co., 65 Oliver St., Boston, Mass."

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Made to Fit All Sockets and Any Voltage.

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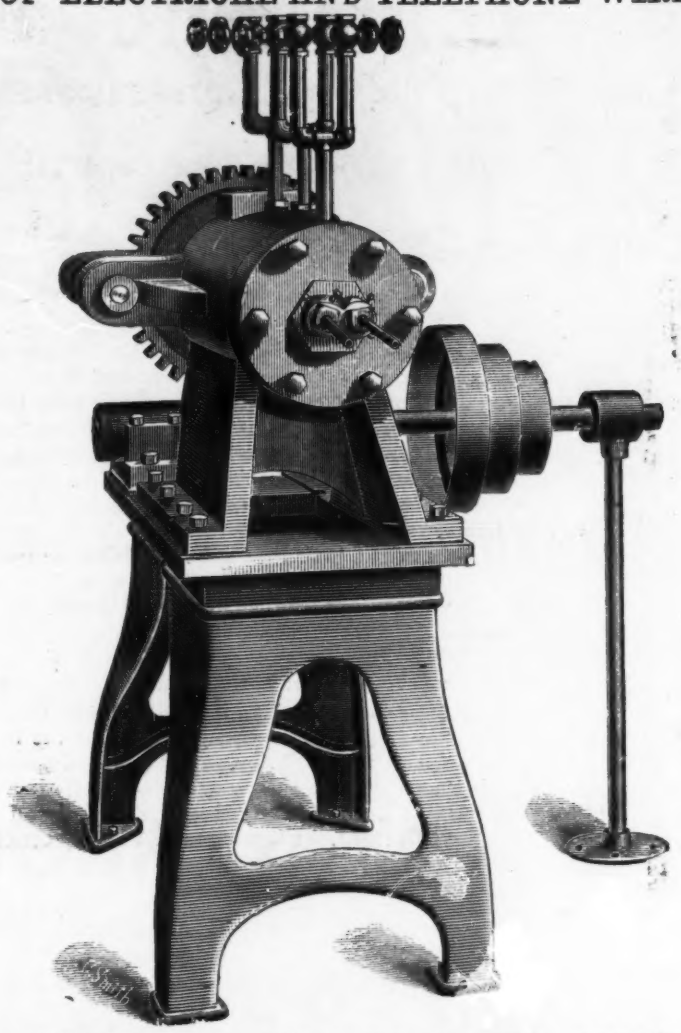

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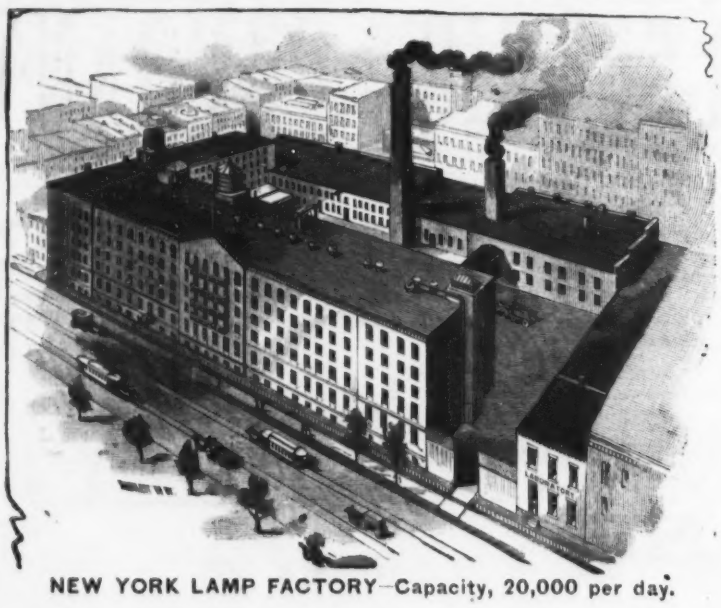

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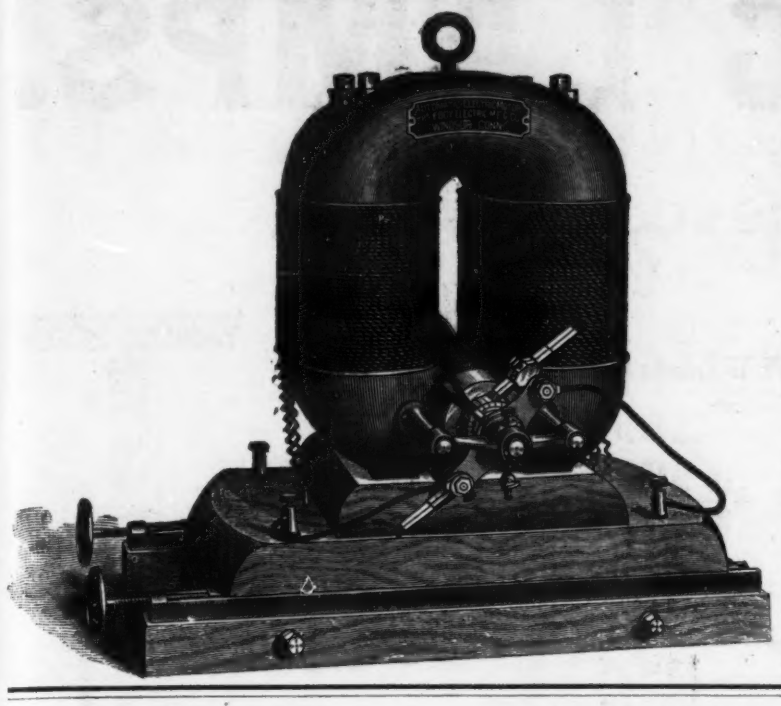

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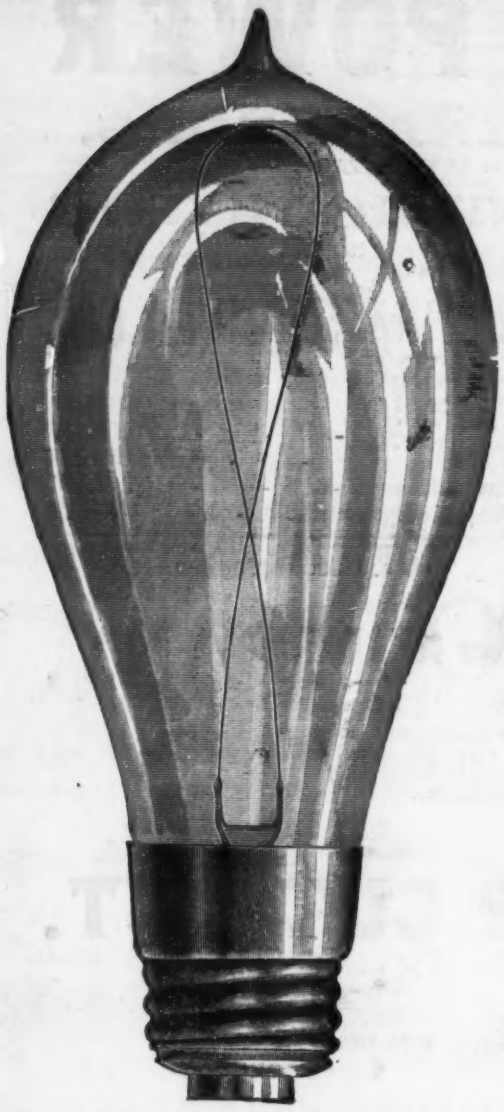

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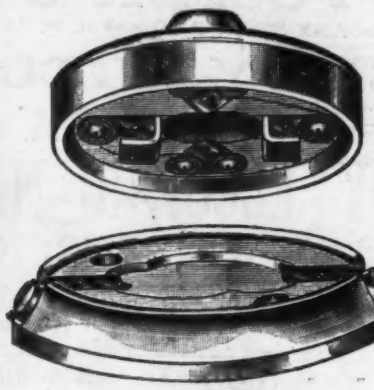

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IT RETAINS ITS CANDLE POWER.
IT WILL NOT DISCOLOR IN USE
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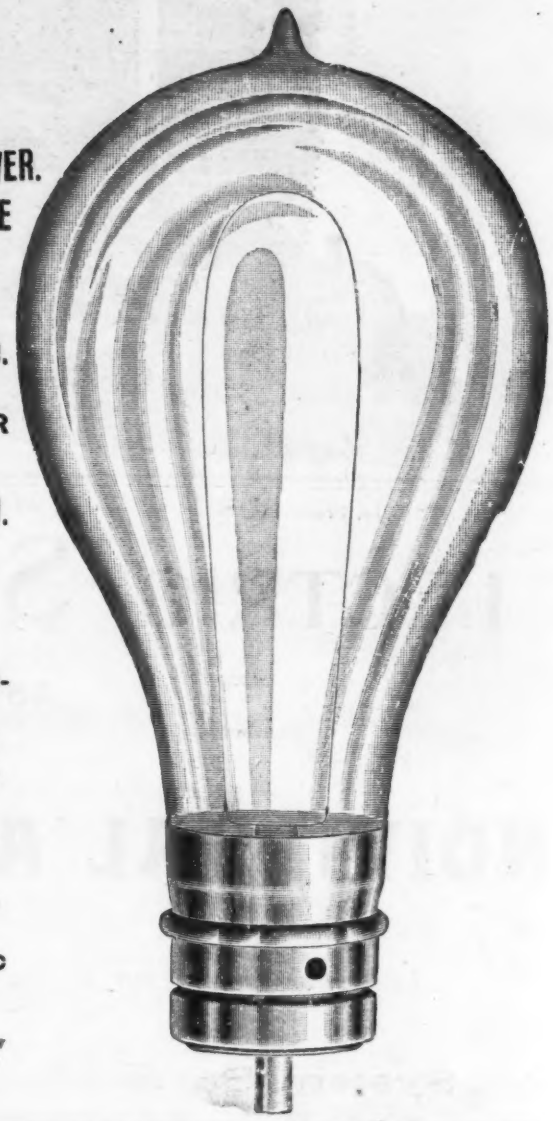
Any Candle Power.
Any Voltage. Any Base.
GIVE IT A TRIAL.
YOU WILL USE NO OTHER



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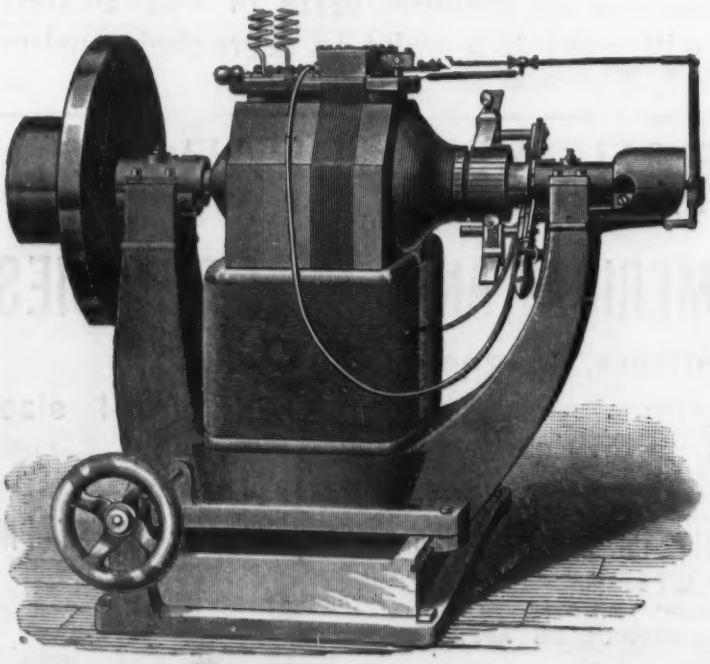
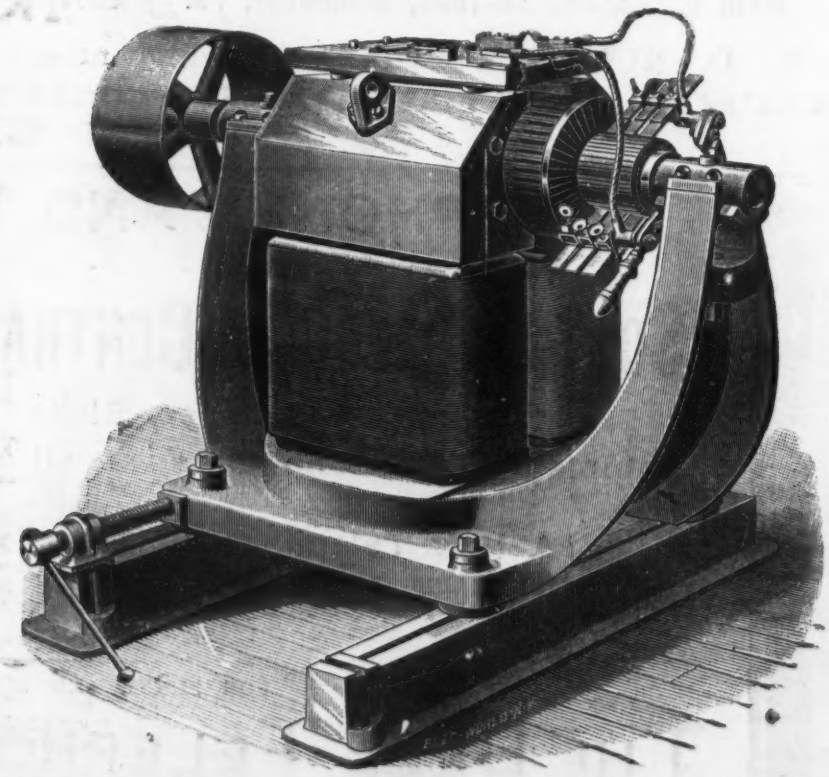
HIGHLY EFFICIENT AND ECONOMICAL. ∴ CONSTANT SPEED UNDER ALL LOADS.





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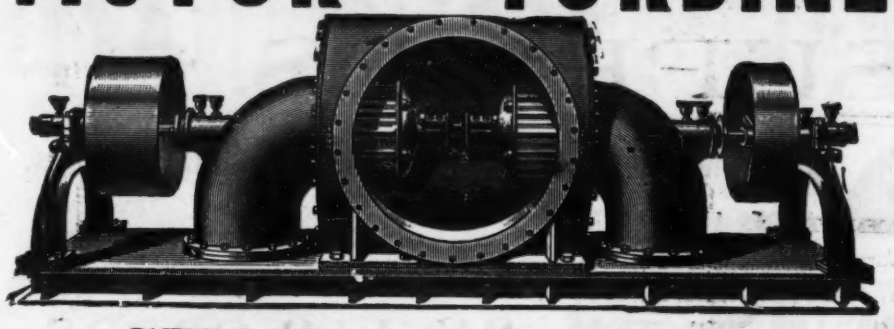

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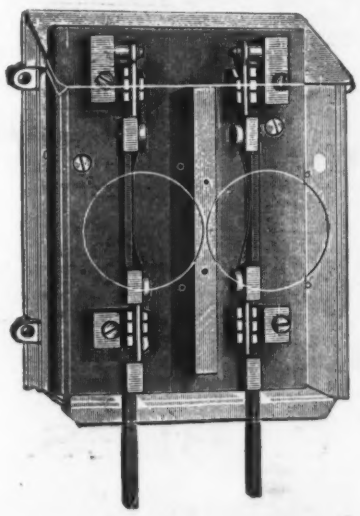

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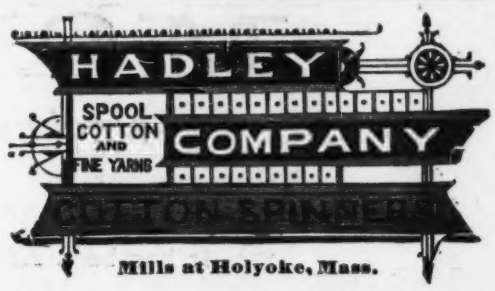

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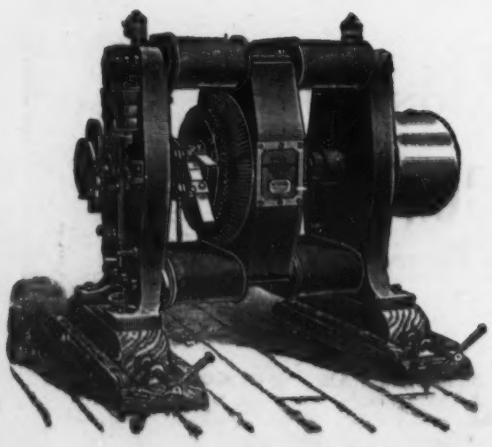

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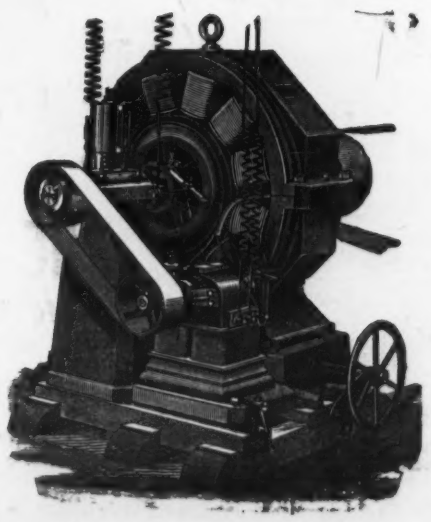

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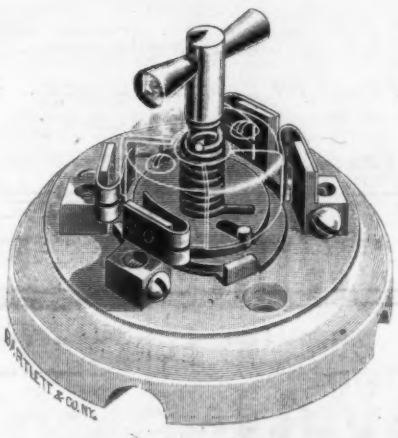

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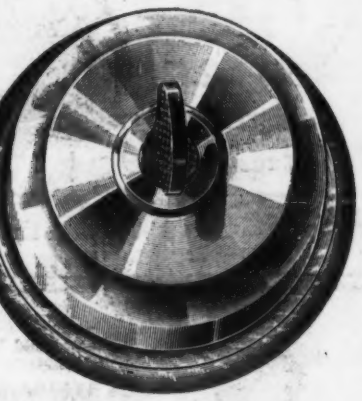

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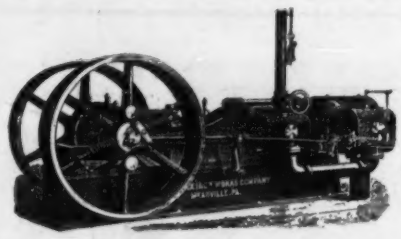

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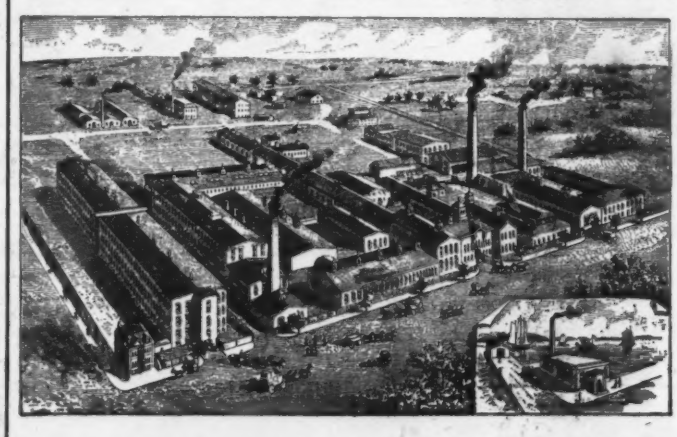

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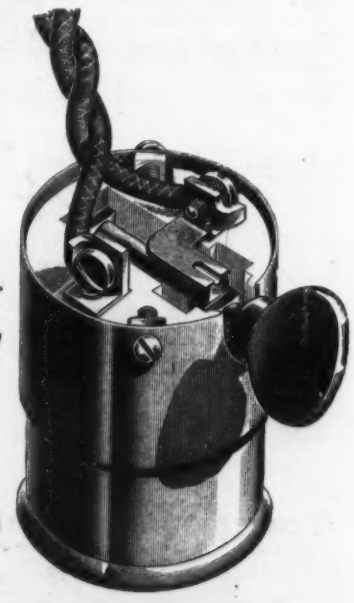

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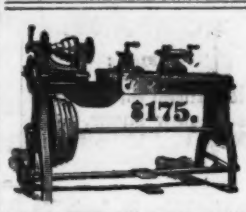

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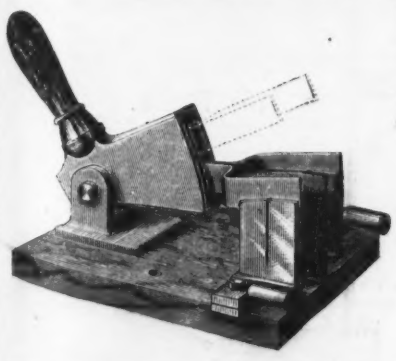

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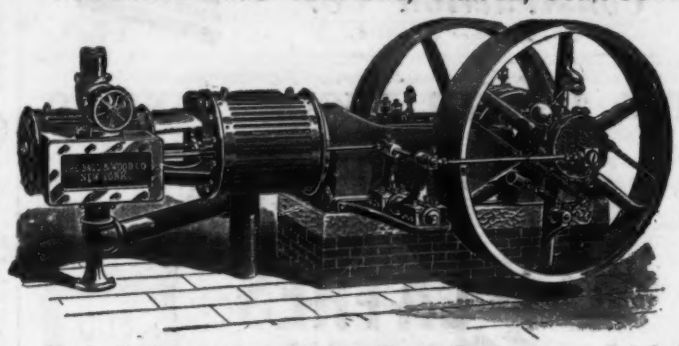

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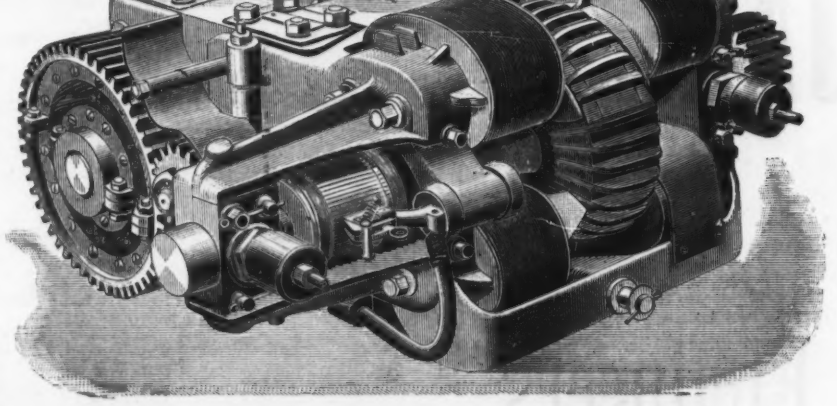

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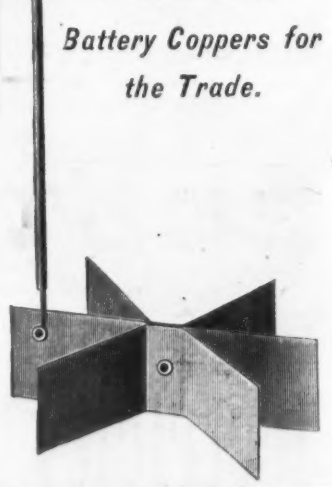

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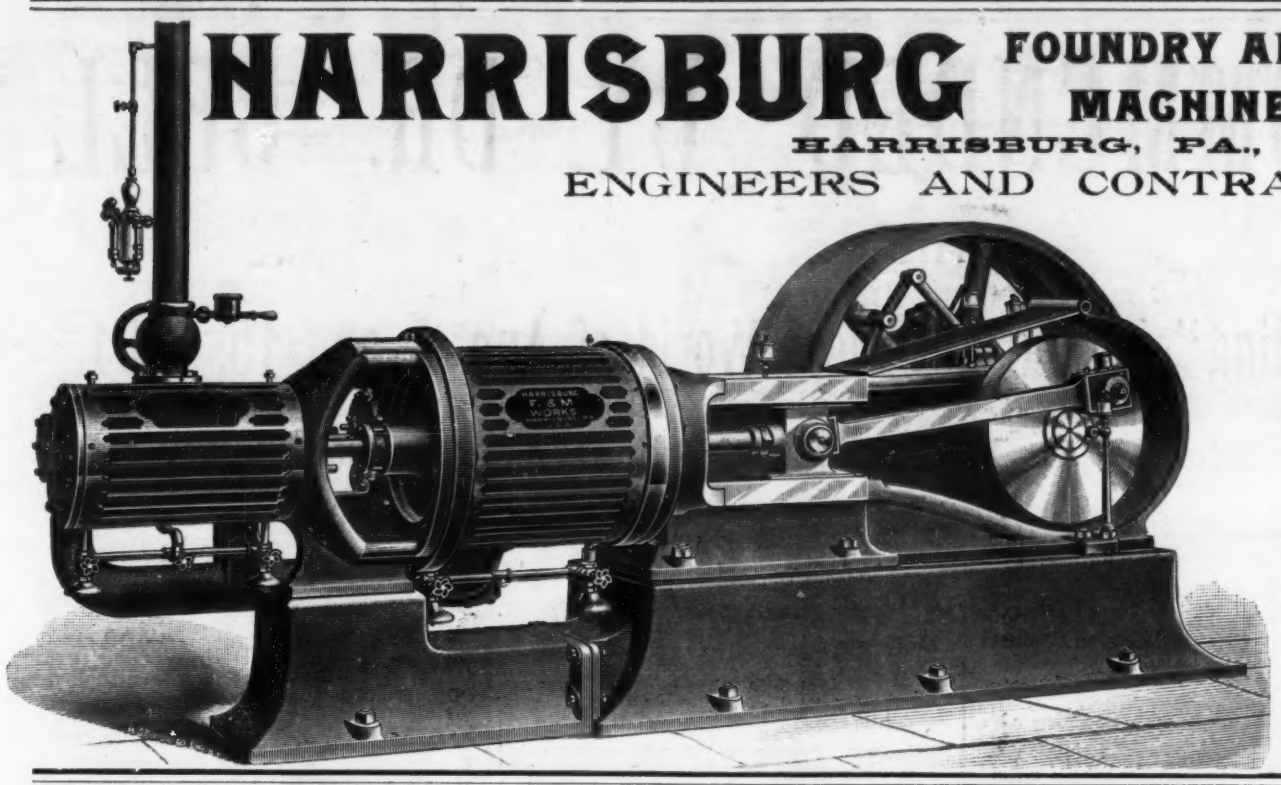

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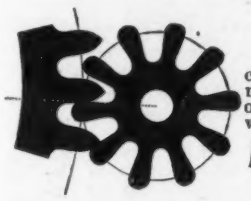

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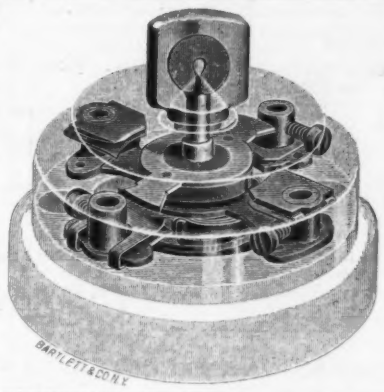

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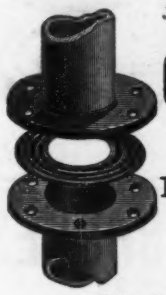

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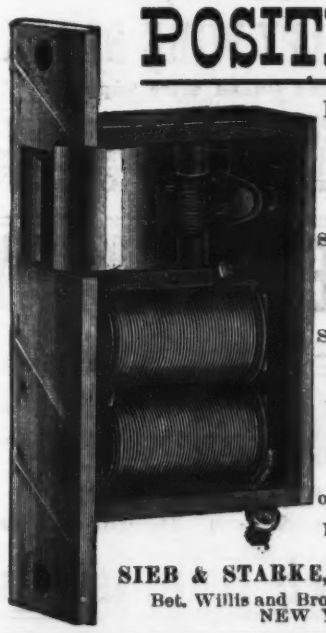

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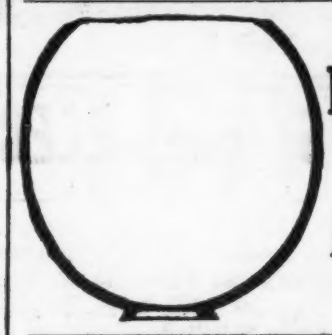

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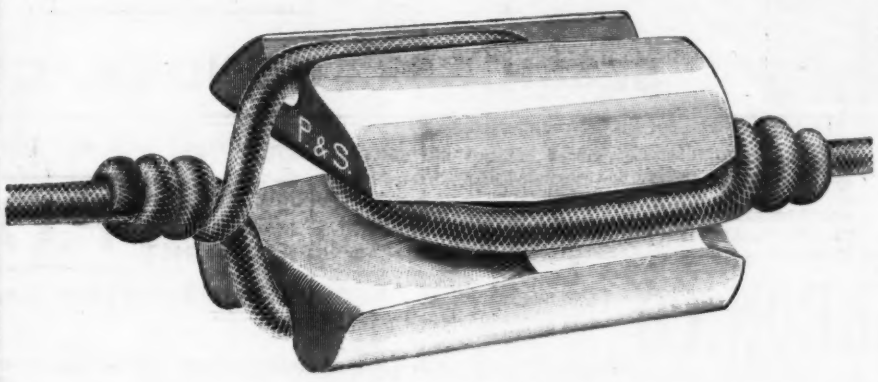

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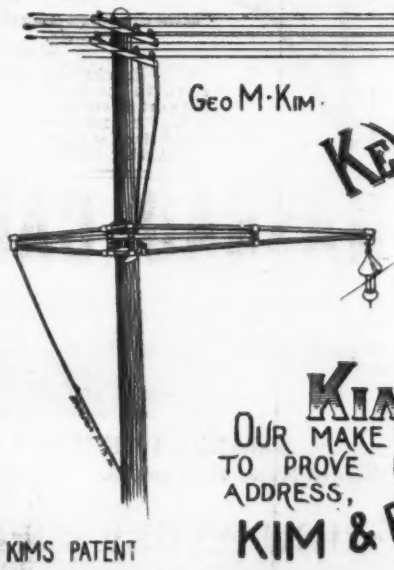

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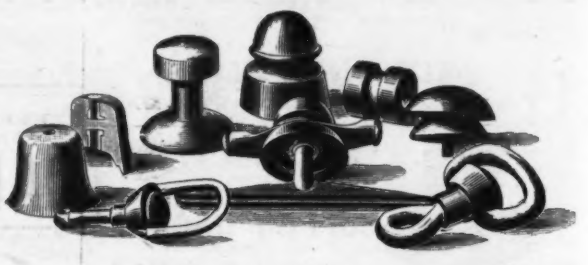

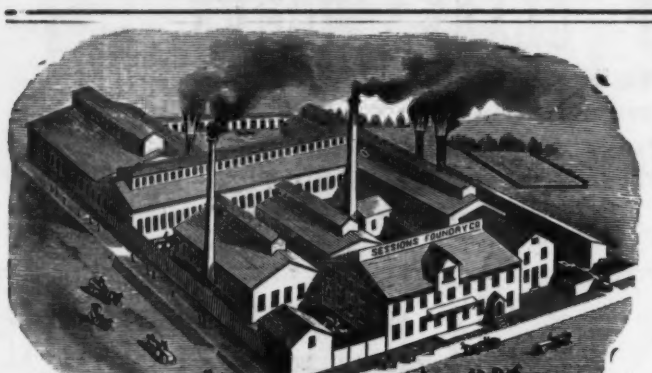

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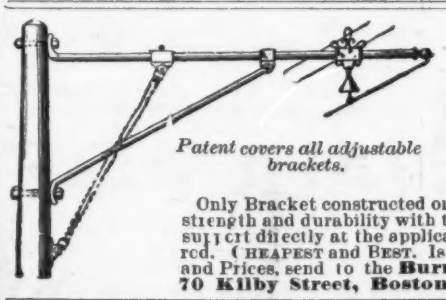

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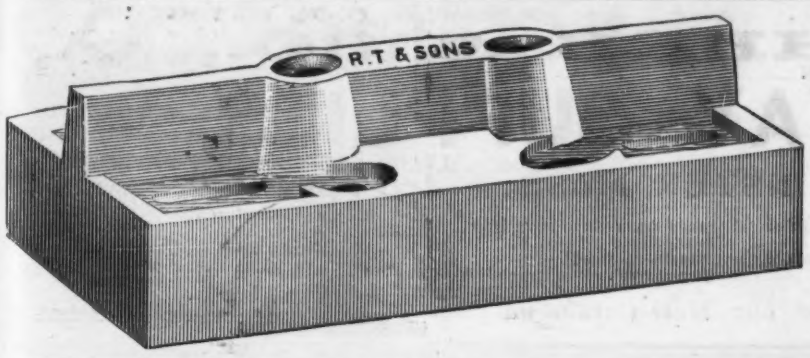

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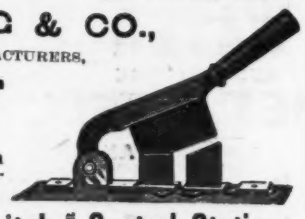

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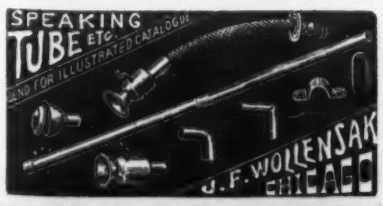

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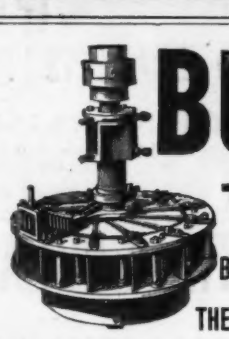

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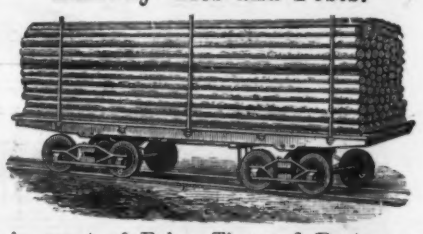

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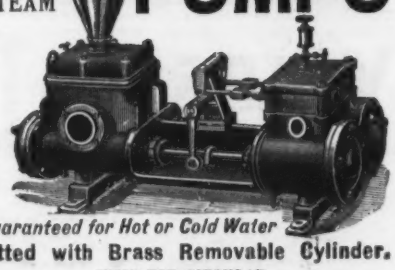

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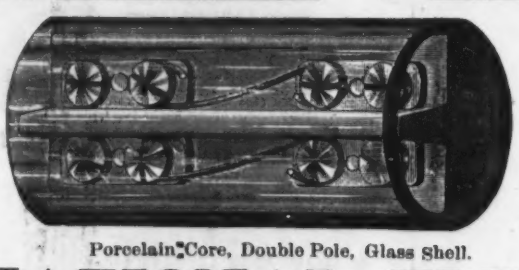

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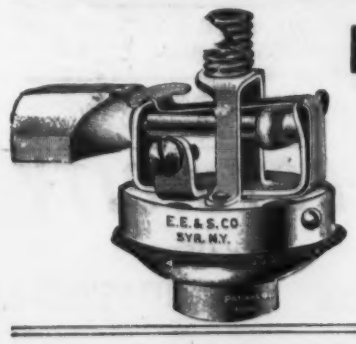

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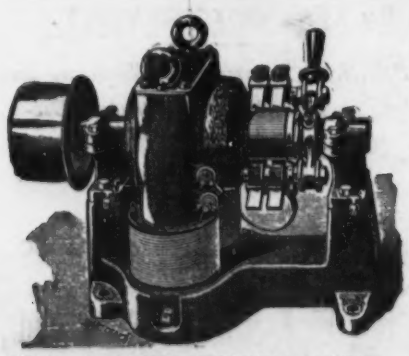

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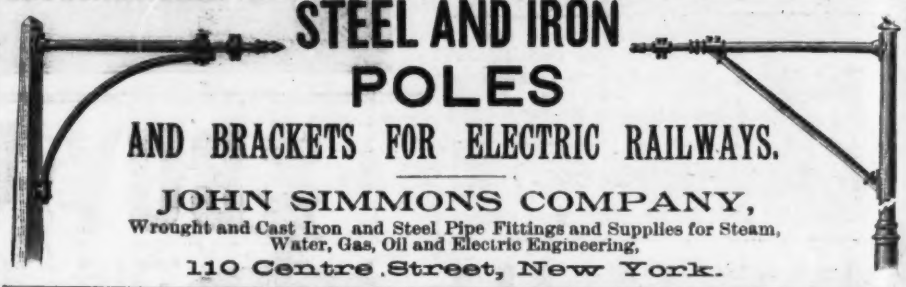

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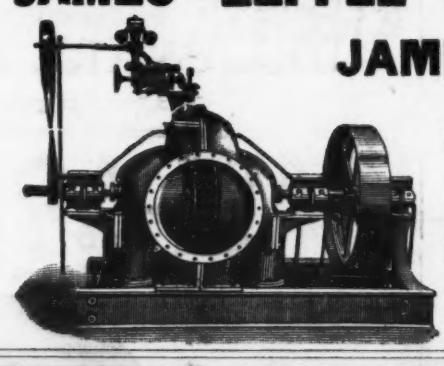

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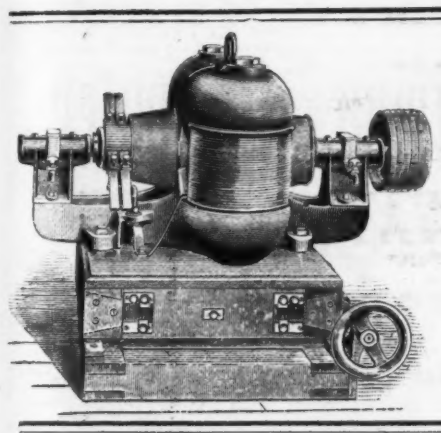

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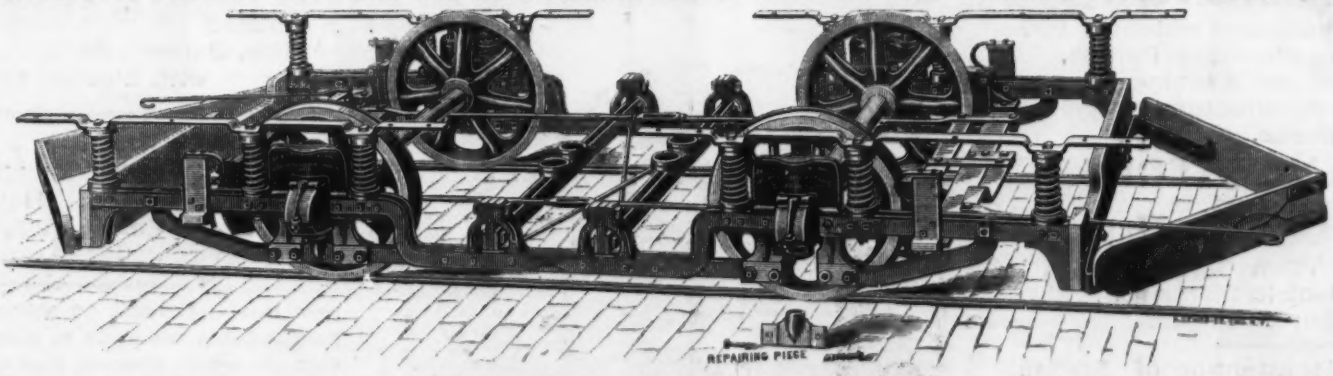

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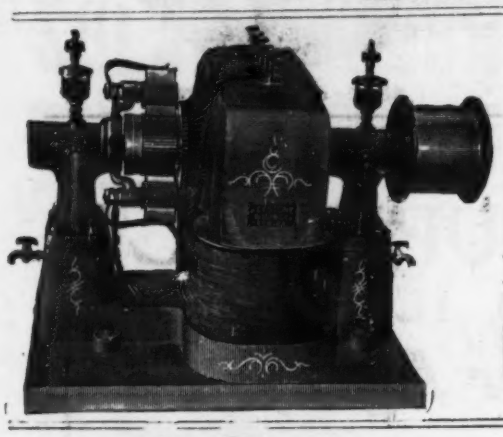

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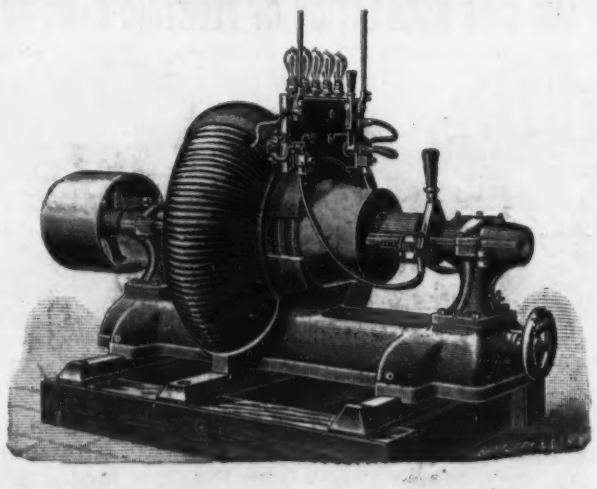

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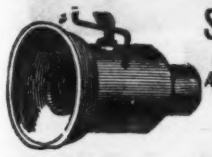
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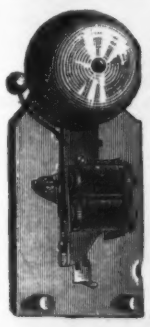
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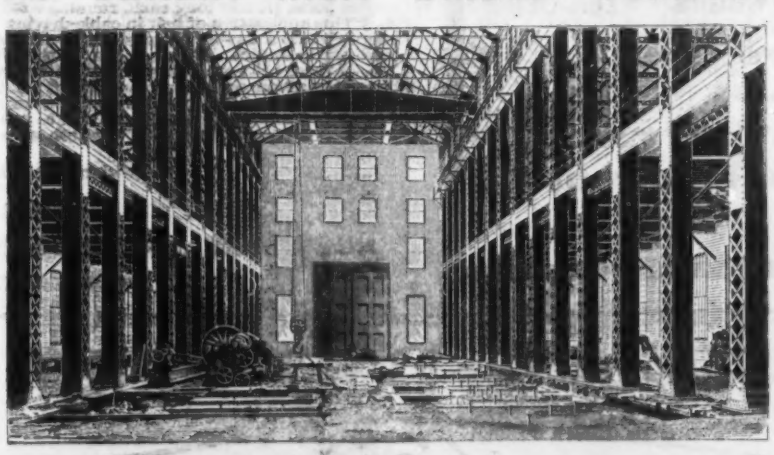

The above illustration shows the interior view of the Machine shop designed and built by us for the Newport News Ship Building and Dry Dock Co., at Newport News, Va. The photograph was taken looking diagonally across the Machine Shop into the gallery floor, and shows the first and second floors in the lean-to and the traveling crane in the main portion of the Machine Shop. The building is 100 ft. in width by 300 ft. in length, the central portion being 50 ft. in width, two stories high, with a wing on each side 25 ft. in width. The floor space in the central portion of the building is served by a hydraulic crane, as shown in the illustration.

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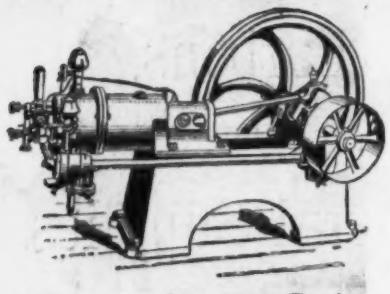

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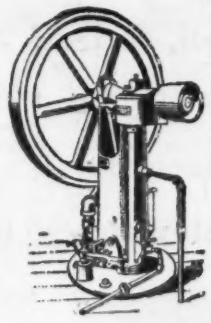

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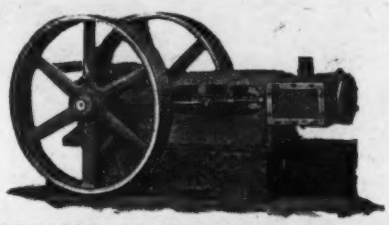

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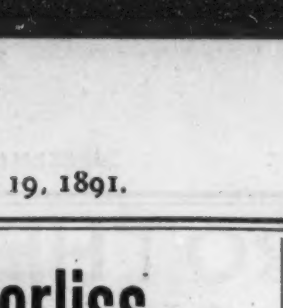

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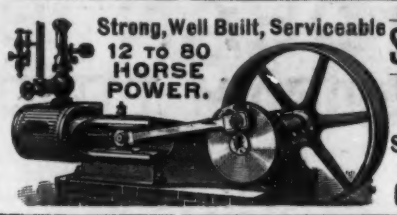

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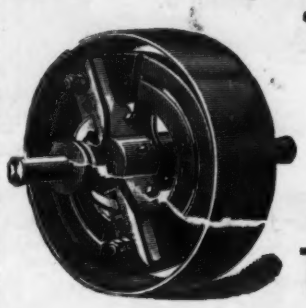

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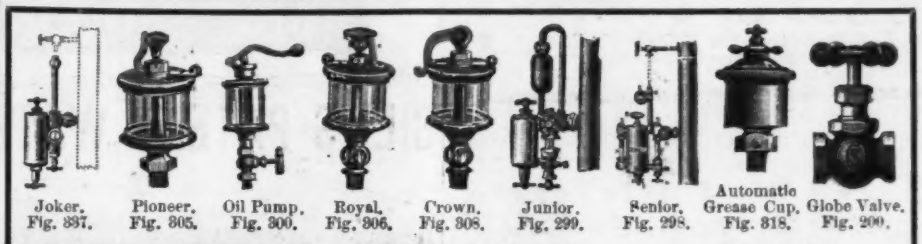

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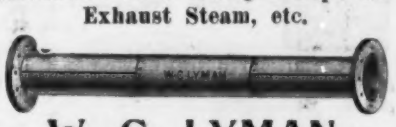

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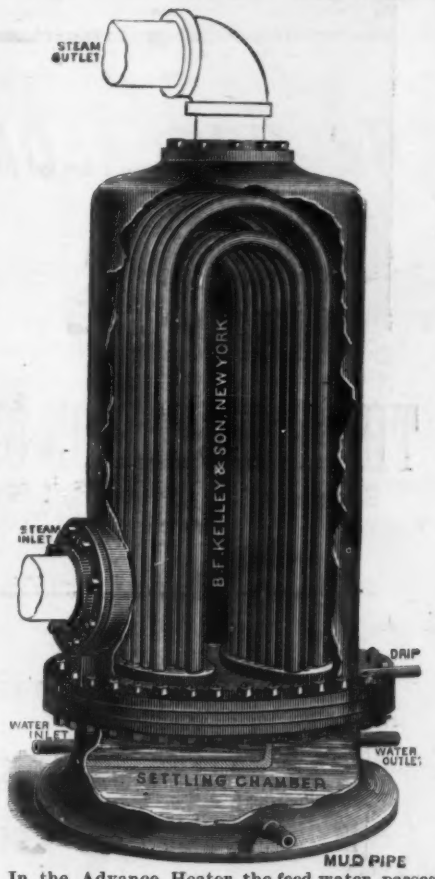

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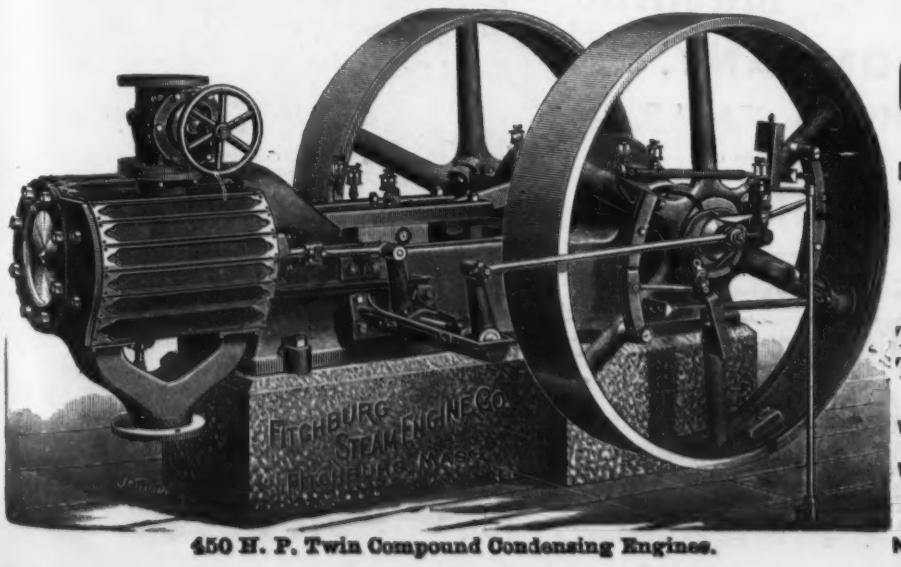

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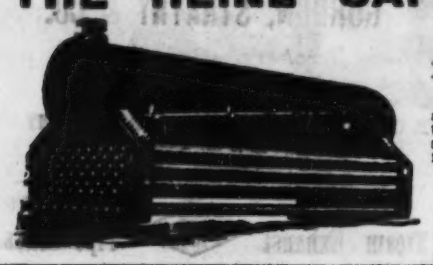

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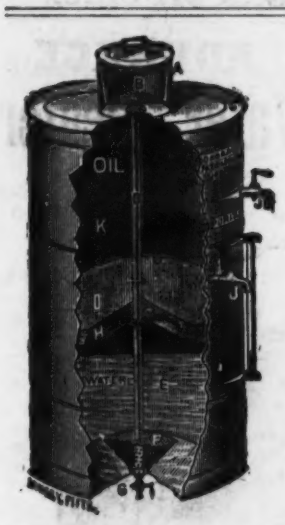

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D. W. Higgins, M. P. P., President.

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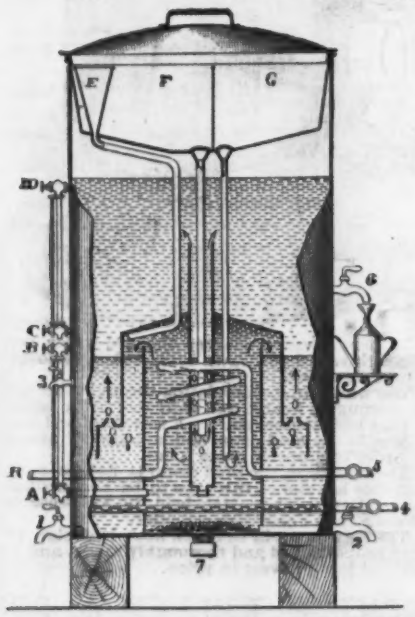

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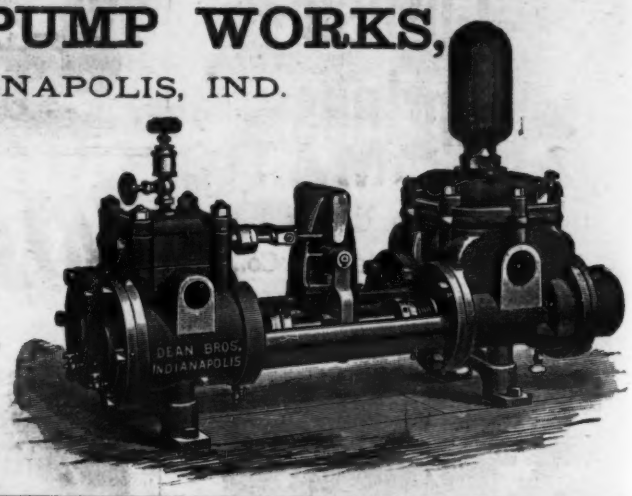

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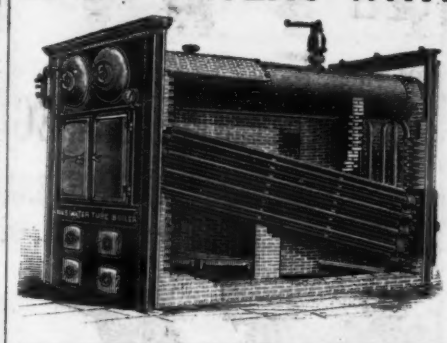

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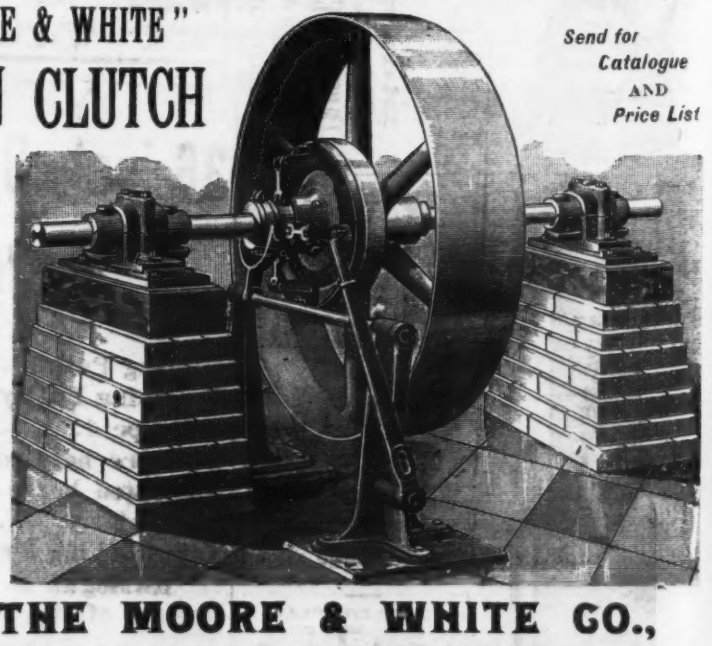

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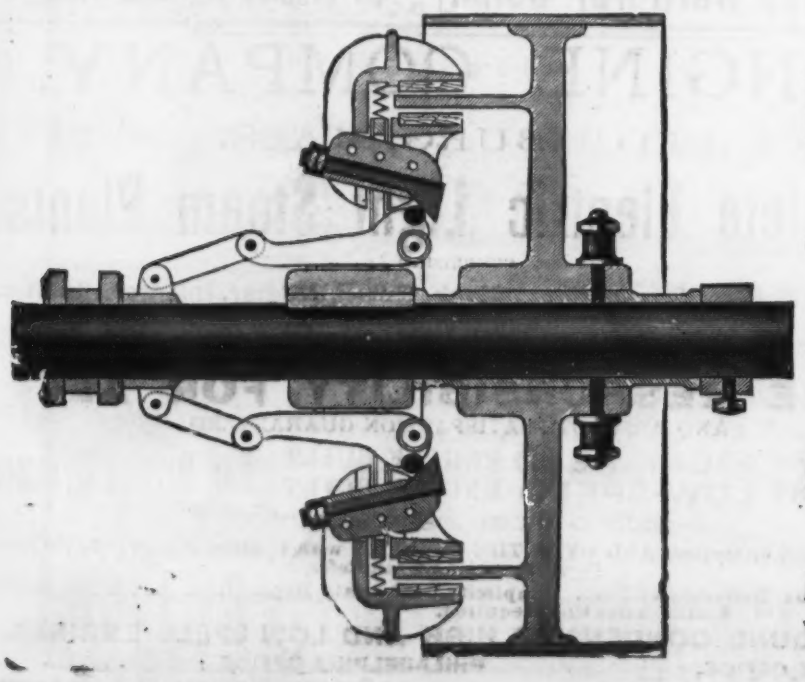

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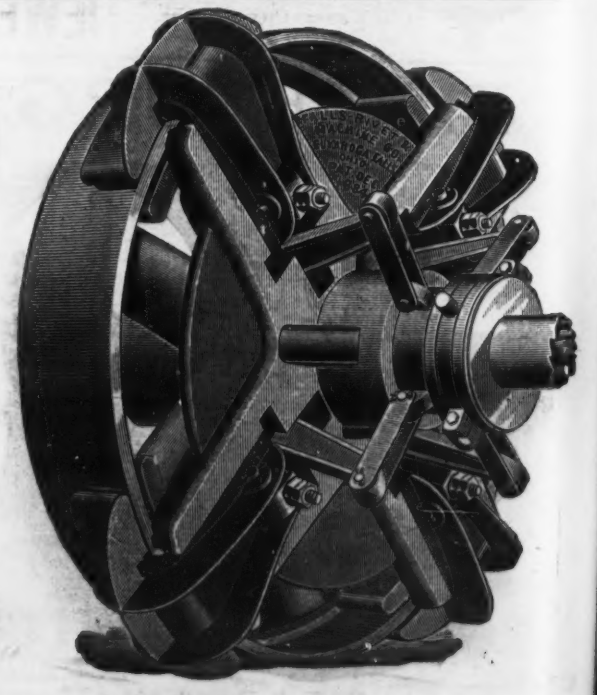

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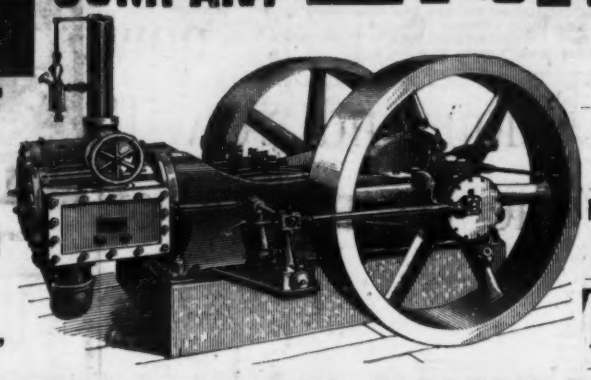

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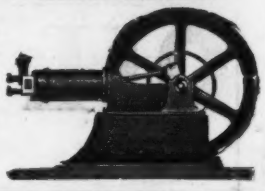

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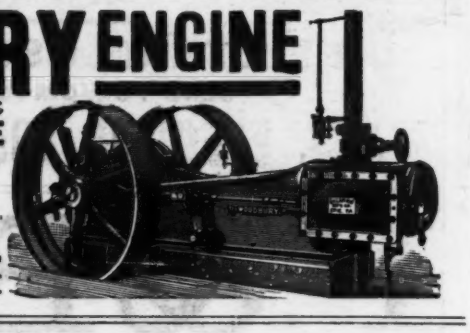

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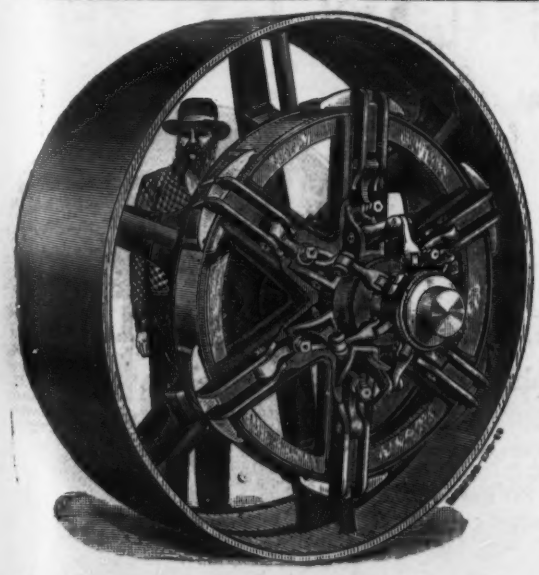

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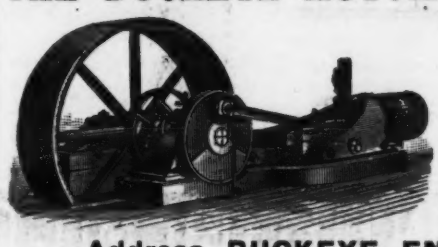

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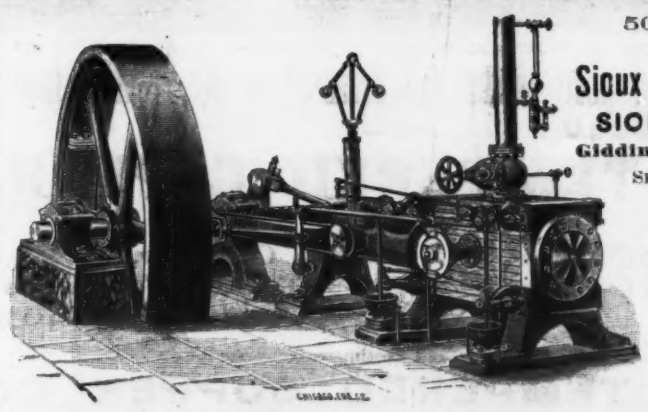

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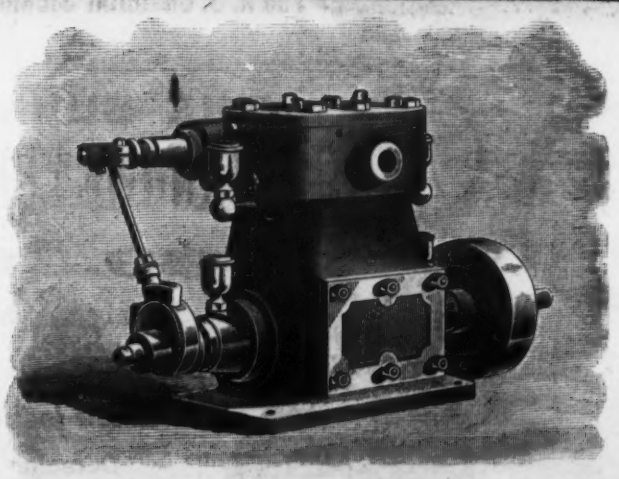

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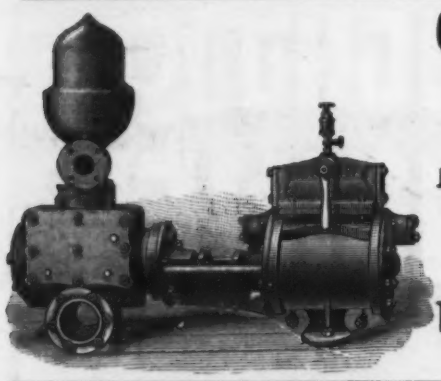

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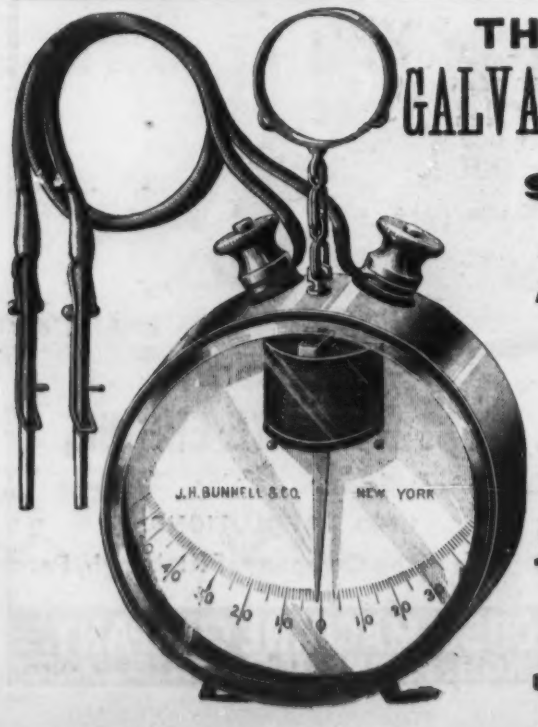

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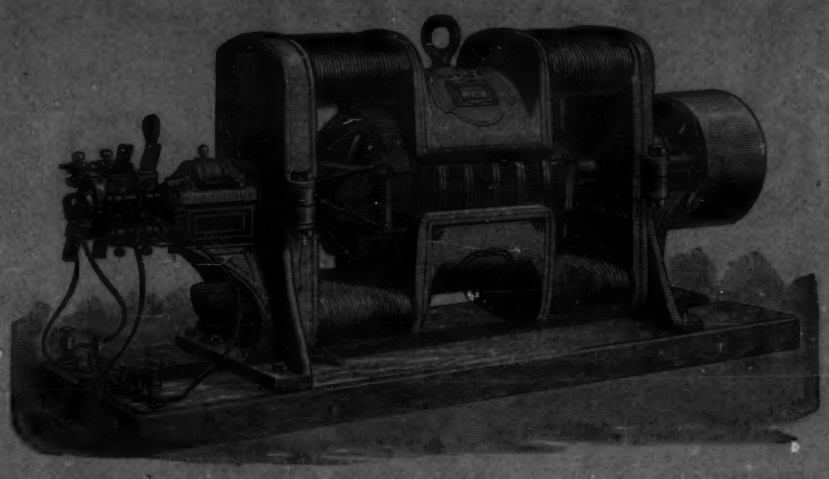

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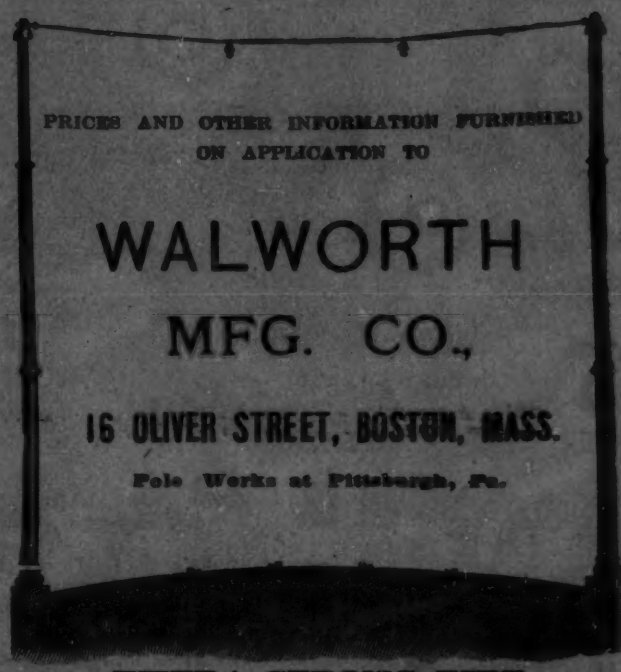
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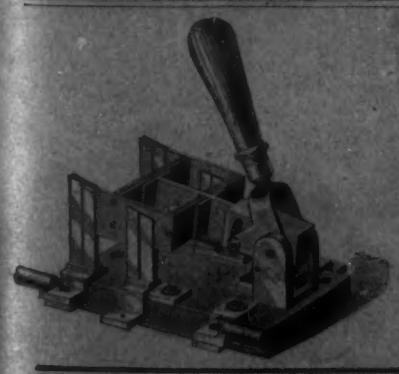

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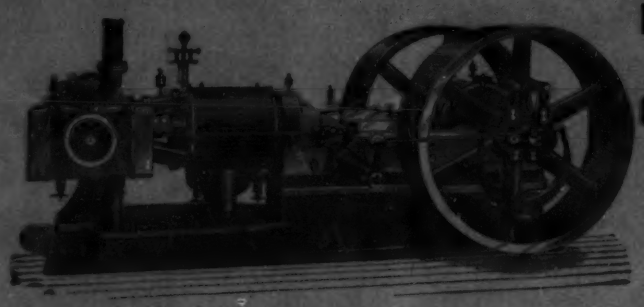

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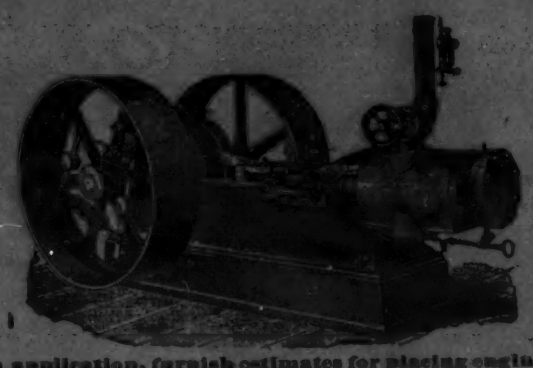
8	by	9
9	"	9
9	"	12
10	"	12
11	"	12
12	"	12
13	"	12
14	"	16
15½	"	16
18½	"	18



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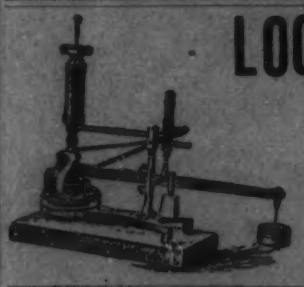

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